WATER QUALITY RESTORATION PLAN FOR THE COOKE CITY TMDL PLANNING AREA

McLaren Pit, 1970's

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Montana Department of Environmental Quality

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Purpose and Water Quality Restoration Plan Elements and Strategies

This document is a water quality restoration plan (WQRP) and Total Maximum Daily Load (TMDL) submittal for several water bodies (streams) located in the Cooke City TMDL Planning Area. Figure E-1 (reference Figure Section) shows the locations of the Cooke City Planning area and some of the primary water bodies of concern. The water bodies in need of TMDL development have been identified on the State of Montana 303(d) list as impaired water bodies that are not fully supporting their beneficial uses, with aquatic life support being the most significant use impairment and metals, pH, and sediment being the pollutants of concern. The overall goal is to identify an approach to improve water quality to a level where beneficial uses are restored and protected. By addressing this goal, the document fulfills the requirements of Section 303 (d) of the Federal Clean Water Act and Title 75, Chapter 5, Part 7 of the Montana Water Quality Act. Table E-1 is a summary of TMDL and restoration plan components and strategies found within this WQRP.

Table E-1: Restoration Plan Components and Strategies Summary

Water Bodies & Pollutants of Concern		- Daisy Creek (pollutants: metals, pH, sediment) - Stillwater River (pollutants: metals, sediment) - Fisher Creek (pollutants: metals, pH, sediment) - Clarks Fork of the Yellowstone River (pollutants: metals, pH) - Miller Creek (pollutants: metals) - Soda Butte Creek (pollutants: metals)
Impaired Beneficial Uses for Each Water Body		- Daisy Creek (impaired uses: aquatic life; cold water fish; drinking water; recreation/aesthetics; agriculture; industry) - Stillwater River (impaired uses: aquatic life; cold water fish; drinking water; recreation/aesthetics) - Fisher Creek (impaired uses: aquatic life; cold water fish; drinking water; recreation/aesthetics; agriculture; industry) - Clarks Fork of the Yellowstone River (impaired uses: aquatic life; cold water fish; drinking water) - Miller Creek (impaired uses: aquatic life; cold water fish; drinking water) - Soda Butte Creek (impaired uses: aquatic life; cold water fish; drinking water; recreation/aesthetics)
Pollutant Sources		- Metals: Mine disturbances, natural background - pH: Mine disturbances, natural background - Sediment: Mine disturbances, roads and trails, natural background
Target Development Strategies		- Numeric values for aquatic life support (metals, pH) - Numeric values for drinking water/domestic use support (metals) - Elimination of objectionable deposits and turbidity from metal precipitates (metals/pH) - Non-toxic levels in stream sediments (metals) - Biota at greater than or equal to 75% of reference conditions (all pollutants) - Stream habitat conditions within 25% of reference stream (sediment)

Numeric TMDL Value Development Strategies		- Based on numeric concentration targets multiplied by stream flow (all metals) - Metals TMDLs used as surrogates for pH - Based on yearly loads and percent reductions in loading (sediment)
Pollutant Load Allocations Strategies		- Performance-based for mine disturbances (applies to metals and pH in all drainages except Soda Butte) - Allocated to loading sources by category with focus on mining and natural background sources (applies to metals in Soda Butte Creek) - Allocated to loading sources by category with focus on mine disturbances, roads and trails, and natural background sources (applies to sediment TMDLs)
Restoration Strategies		- New World Mining District restoration efforts currently underway for mine disturbances and related erosion control practices (benefits all major water bodies with initial focus on sources within the Daisy, Fisher, and Miller Creek drainages) - Additional National Forest Service erosion control practices and mine restoration efforts where needed (all water bodies) - Further characterization and possible restoration of mine disturbances on private lands (for some water bodies; key strategy component for Soda Butte Creek drainage) - Significant water quality and related monitoring including additional source characterization (all water bodies) - Adaptive management approach to identify any necessary changes to targets, TMDLs or load allocations (all water bodies)
Margin of Safety		- Addition of biota targets in addition to metals concentration targets - Application of chronic aquatic life numeric standards - Built in margins of safety within existing numeric water quality standards - Significant monitoring efforts associated with metals related watershed characterization and restoration efforts - Metals and pH targets apply during high and low flow conditions with considerations for changing hardness conditions - Phased approach for sediment TMDLs and allocations - Use of relatively undisturbed stream(s) for sediment target reference condition
Seasonal Considerations		- Metals and pH targets apply during high and low flow conditions with considerations for changing hardness conditions - Metals and pH impairment and loading conditions evaluated at high and low flow conditions - Existing and future monitoring addresses high and low flow conditions for metals and pH - Sediment targets, source assessment and controls are based on modeling and monitoring efforts intended to capture impacts from seasonal and event-driven loading conditions

Problem Description

The six impaired water bodies (also referred to as streams) in the Cooke City TMDL Planning Area, as shown by Figures E-1 and E-2, are Daisy Creek, the upper 22 miles of the Stillwater River, Fisher Creek, the Clarks Fork of the Yellowstone River (Clarks Fork River) upstream of the Montana - Wyoming border, Miller Creek, and segments of Soda Butte Creek. No other water bodies in the Cooke City Planning Area have yet been identified as being impaired and in need of Total Maximum Load development, although the data presented within this report suggests that some of the additional tributaries to Soda Butte Creek are possibly impaired. The restoration strategy for Soda Butte Creek addresses these potential impairment conditions.

Several different metals impact each impaired stream. Many of the metals create toxic conditions in the water column or in sediments at levels that negatively impact aquatic life and/or exceed human health criteria for drinking water. Some metals also impact aesthetic qualities creating turbid water conditions, and/or creating objectionable sludge deposits or staining in the streambed. The specific metals of concern include copper, iron, zinc, manganese, lead, cadmium, silver, and aluminum. Copper and iron typically represent the greatest negative impacts to water quality in most of the six streams. Low pH conditions are also associated with the elevated metals, further impacting aquatic life and other beneficial uses in Daisy Creek, Fisher Creek, and the Clarks Fork River.

Excessive sediment accumulation in the streambed because of human caused conditions is also a problem in Daisy Creek, the Stillwater River, and Fisher Creek. The sediment can smother aquatic life and cause overall negative impacts to habitat conditions.

Mining disturbances primarily associated with historical adits, waste rock and tailings represent the primary sources of increased metals loading from human activities. Problems associated with low pH (acidic conditions) are also related to many of these same metals sources. Many of these same mining disturbances along with significant road and trail networks represent the primary sources of increased sediment loads from human activities. In addition, natural background conditions also contribute to both metals and sediment loads to the streams, perhaps at elevated levels that alone could negatively impact beneficial uses in some of the six water bodies.

Mine disturbances and roads in the Daisy Creek drainage are the cause of essentially all of the controllable problems in both Daisy Creek and the upper portion of the Stillwater River. In a similar manner, mine disturbances and roads in the Fisher Creek drainage are the cause of essentially all of the controllable problems in both Fisher Creek and the Clarks Fork River upstream from the Wyoming border. Although mine disturbances in Miller Creek are a significant source of metals in Soda Butte Creek, there are additional significant sources of metals to Soda Butte Creek, such as the McLaren Tailings, not located in the Miller Creek Drainage.

Restoration Targets and TMDLs

Restoration targets and TMDLs are developed for each stream. The targets reflect conditions necessary to meet Montana Water Quality Standards and, most importantly, support applicable beneficial uses. For aquatic life and cold water fish uses, the target goals are to provide stream conditions that can support a healthy aquatic life community based on stream capabilities. This includes the ability to support a self-sustaining fishery along with healthy macroinvertebrate and periphyton communities. For the human health/domestic water related use as well as industrial and agriculture uses, the goal is to maintain state waters in a condition that supports the use of this valuable resource for a broad range of human activities associated with a use either directly from the stream of concern or from downstream water bodies which rely on these and other upstream tributaries as a source of clean water.

Once a target is identified, then conditions necessary to meet that target can be defined in a way that meets the definition of a TMDL or surrogate TMDL, and an overall allocation approach can be developed to address restoration goals. In other words, the targets describe the desired conditions, and the TMDL and allocation help describe how these conditions can be met. Table E-2 is a summary of the metals and pH targets applicable to each impaired water body. The metals targets are based on the numeric water quality standards set at concentrations that support aquatic life, human health, and all other beneficial uses. Additional metals targets are based on elimination of objectionable streambed deposits and turbidity. To address potentially synergistic affects and to add a margin of safety to the overall restoration process, additional targets apply to all water bodies based on biota being greater than or equal to 75% of a reference stream that represents desirable conditions.

Metals targets, TMDLs, and estimated load reductions are all analyzed at high and low flow conditions to address the complete range of seasonal impacts. Addressing these flow ranges and the varying water quality conditions associated with them helps to ensure that restoration planning is geared toward meeting the metals and pH standards all year long.

For the metals targets associated with numeric standards, the TMDLs are calculated by multiplying the applicable target concentration by the stream flow to promote a problem solving approach that can be based on consideration of load contributions from various sources or source areas. An assumption within this plan is that meeting the TMDLs based on numeric standards is expected to satisfy all other metals related targets associated with objectionable sludge deposits, stream sediment chemistry, turbid conditions, pH, and biota indicators.

Water quality standards for sediment are narrative, and the sediment targets are developed to reflect desired conditions that would satisfy Montana Department of Environmental Quality (MDEQ) interpretations of relevant water quality standards. These sediment targets are only developed for the three streams identified as being impaired from sediment: Daisy Creek, Stillwater River, and Fisher Creek.

The sediment TMDLs are based on sediment modeling conducted by Forest Service personnel and professional judgement as to what conditions will satisfy the target. Because of the nature of sediment transport, yearly loads, along with yearly load reductions for some water bodies, are used as surrogate TMDLs. The uncertainty associated with this approach requires an adaptive management (phased) strategy whereby monitoring will be used to verify that anticipated load

Table E-2. Metals and pH Water Quality Restoration Targets for Impaired Water Bodies in the Cooke City TMDL Planning Area

Pollutant	Daisy Creek and Stillwater River Targets	Fisher Creek and the Clarks Fork River Targets	Miller Creek and Soda Butte Creek Targets	Limiting (most sensitive) Beneficial Use
Copper[1]	5.2 ug/l (high flow) 7.3 ug/l (low flow) sediment concentrations at non-toxic levels	2.8 ug/l (high flow) 4.2 ug/l (low flow) sediment concentrations at non-toxic levels	4.7 ug/l (high flow) 7.3 ug/l (low flow) sediment concentrations at non-toxic levels	Aquatic Life
Cadmium[1]	0.16 ug/l (high flow) 0.22 ug/l (low flow)	0.10 ug/l (high flow) 0.14 ug/l (low flow)	0.15 ug/l (high flow) 0.22 ug/l (low flow)	Aquatic Life
Lead[1]	1.3 ug/l (high flow) 2.2 ug/l (low flow) sediment concentrations at non-toxic levels	0.54 ug/l (high flow) 0.99 ug/l (low flow) sediment concentrations at non-toxic levels	1.2 ug/l (high flow) 2.2 ug/l (low flow) sediment concentrations at non-toxic levels (Miller Creek)	Aquatic Life
Zinc[1]	67 ug/l (high flow) 94 ug/l (low flow)	37 ug/l (high flow) 55 ug/l (low flow)	61 ug/l (high flow) 94 ug/l (low flow)	Aquatic Life
Iron	300 ug/l (all flows) - no visible streambed deposits associated with controllable human causes	300 ug/l - no visible streambed deposits associated with controllable human causes	1000 ug/l (both streams) 300 ug/l (both streams) no visible streambed deposits associated with controllable human causes below McLaren Tailings in Soda Butte Creek	Aquatic Life & Drinking Water (domestic use); Aesthetics
Manganese	50 ug/l	50 ug/l	50 ug/l	Drinking Water (domestic use)
Aluminum	no precipitants causing visible turbidity at low flow conditions	- 87 ug/l (dissolved aluminum in pH range of 6.5 to 9.0; outside of this range there is no applicable dissolved aluminum target) - no precipitants causing visible turbidity at low flow conditions	87 ug/l (dissolved)	Aquatic Life/Aesthetics
Silver	NA	0.37 ug/l (high flow) 0.84 ug/l (low flow)	NA	Aquatic Life
PH	6.0 to 9.0	6.0 to 9.0	NA	Aquatic Life
Metals & pH	Macroinvertebrate and periphyton communities at 75% or greater of reference stream conditions	Macroinvertebrate and periphyton communities at 75% or greater of reference stream conditions	Macroinvertebrate and periphyton communities at 75% or greater of reference stream conditions	Aquatic Life

Notes:
1. All targets for this pollutant are estimated based on predicted hardness values after completion of restoration activities, actual values will be determined by hardness as defined in Appendix A

reductions from restoration activities (primarily erosion control) result in meeting the target. If the target is not met, then a new TMDL and associated load allocations will be identified to reflect the need for a lower yearly load and increased load reductions via additional erosion controls.

Load Allocations and Implementation Strategy

An approach based on the performance of specific source control actions is the primary allocation approach and implementation strategy to address metals problems for all water bodies except Soda Butte Creek. These control actions are associated with New World Mining District Response and Restoration Project activities that are underway in the Daisy, Fisher and Miller Creek drainages. This effort will presumably satisfy applicable metals and pH restoration targets for Daisy Creek, Fisher Creek, the Stillwater River, and some or all of the remaining streams in the Cooke City area depending on funding conditions and the results from further characterization of potentially significant metals sources.

Although Miller Creek restoration discussed above can significantly improve water quality in Soda Butte Creek, there is still a lack of firm commitments to address all other significant metals loading sources to Soda Butte Creek, such as the McLaren Tailings. These other sources, which are mainly associated with mine disturbances and natural background conditions, are instead given load allocations either by source category or by individual source areas. The load allocations represent loading conditions that would support the overall TMDL and targets within all of Soda Butte Creek, and can help direct future characterization and restoration work.

The allocation approach and implementation strategy for sediment sources is similar to the above metals approach. It is anticipated that New World Mining District efforts will address most of the necessary load reductions. Any additional load reduction needs will likely be addressed via additional Forest Service erosion control practices for roads and trails.

This document also includes a monitoring plan that identifies some data gaps that should be addressed and provides recommendations for further study to help direct future restoration activities, particularly in the Soda Butte Creek drainage. The monitoring plan also addresses the need to determine overall progress toward meeting targets at least once every five years as directed by Montana State Law.

SECTION 1.0
INTRODUCTION

1.1 Water Quality Restoration Planning

This document is a water quality restoration plan (WQRP) and Total Maximum Daily Load (TMDL) submittal for the Cooke City TMDL Planning Area (Figure E-1). The overall goal is to identify an approach to improve water quality to a level where beneficial uses are restored for all impaired water bodies in the Cooke City TMDL Planning Area and ensure that Montana water quality standards are not violated.

Under Montana State Law, an "impaired water body" is defined as a water body or stream segment for which sufficient credible data shows that the water body or stream segment is failing to achieve compliance with applicable water quality standards (Montana Water Quality Act; Section 75-5-103). Furthermore, State Law directs the Montana Department of Environmental Quality (MDEQ) to develop TMDLs for impaired water bodies (Montana Water Quality Act; Section 75-5-703). A TMDL is a pollutant budget developed at a level where water quality standards will not be exceeded. The TMDL accounts for loads from point and nonpoint sources in addition to natural background loads. Appendix A provides additional details on the definition of a TMDL and how it fits into water quality planning.

To satisfy Montana State Law, and the Federal Clean Water Act, TMDLs are developed for each water body-pollutant combination and are presented within the context of a water quality restoration plan. The WQRP not only includes the TMDL but also includes information that can be, or in some cases, is being used to effectively restore water quality using a coordinated and scientifically based approach.

The Cooke City Planning Area is one of 91 planning areas in the State of Montana where one or more water bodies have been, and/or currently are listed as having one or more pollutants or other causes leading to impaired conditions. A planning area typically encompasses a complete watershed or significant portion of a watershed. The Cooke City Planning Area is unique because it encompasses the upper drainages of three different watersheds due to the close proximity of the stream segments addressed, the similar nature of impairment conditions, and the ongoing coordination of restoration efforts for many of the water bodies in the planning area. The three watersheds that the work is associated with are the Stillwater River, the Clarks Fork of the Yellowstone, and the Yellowstone Headwaters (specifically the Soda Butte Creek drainage), all of which are part of the Yellowstone River basin. By addressing impairment conditions in these three watersheds, potentially significant impairment contributions and associated needed pollutant reductions for downstream water bodies in other TMDL planning areas are also addressed. The extent that these upstream pollutant reductions help address any downstream beneficial use support concerns will be evaluated further as restoration plans are developed for the downstream TMDL planning areas.

As discussed in Appendix A, the water quality restoration plan and the TMDL can be used to help focus ongoing programmatic efforts in a direction that helps ensure proper consideration of water quality impairments and applicable Montana water quality standards. Much of the Cooke City area is covered by existing state and federal programs that address many of the specific TMDL development requirements, often at a level of detail not typically available for the majority of water bodies in Montana. Because of this significant ongoing effort, this plan generally references much of this ongoing work and the information found in associated planning documents.

1.1.1 Water Bodies and Pollutants of Concern

Section 303 of the Clean Water Act requires states to submit a list that includes impaired water bodies (streams, lakes, wetlands) to the U.S. Environmental Protection Agency (EPA) every two years. An impaired water body is a water body that does not satisfy state water quality standards and does not fully support all designated beneficial uses for that water body. The 303(d) List identifies which beneficial uses are impaired and indicates the probable causes (i.e., the pollutant such as metals) and the probable sources of the impairment (i. e., activities, land uses, or conditions such as mining or roads). Table 1-1 provides 303(d) listing information for the water bodies of concern in the Cooke City TMDL Planning Area. Table 1-1 includes the water body names and probable causes for the 1996, 1998, and 2000 EPA-approved 303(d) lists. Figure E-2 shows the locations of these water bodies as well as key tributaries in the area.

The Montana 2000 303(d) List is the most current EPA-approved list and is based on more rigorous scientific analyses in comparison to past 303(d) Lists. A ruling by the U.S. District Court (CV97-35-M-DWM) on September 21, 2000 stipulates that the state of Montana must complete "all necessary TMDLs for all waters listed as impaired or threatened on the 1996 303(d) List". This would mean that a TMDL needs to be developed for each pollutant (probable cause) and water body combination identified in Table 1-1 for the 1996 list or any new pollutant-water body combinations added in later lists. The exception is where subsequent data and assessment work reveals that there is no impairment associated with the pollutant of concern, meaning that a TMDL is not necessary for the purpose of restoring water quality and associated beneficial uses.

Review of Table 1-1 shows that metals are the most commonly listed cause of impairment. Metals can include anywhere from one to several different specific metal compounds, each representing a unique pollutant in need of TMDL development for the water body of concern. For each water body in the Cooke City area, the metals of concern can include any one or all of the following: copper, cadmium, aluminum, zinc, lead, iron, and manganese. All metals have numeric standards set at levels necessary to support specific beneficial uses.

Sediment is another listed cause of impairment in Table 1-1. Sediment is a broad pollutant term that can lead to beneficial use support problems from such things as deposition of the sediment in the water body or loss of water clarity. Terms such as suspended solids (meant to represent suspended sediment in this document) and siltation can be considered under the broad category of sediment from a pollutant control and TMDL development perspective (EPA, 1999). There are no numeric standards for sediment. DEQ has developed guidance (Water Quality Assessment Process and Methods; Appendix A to the 2000 303(d) List) that can be used to define a water body as being impaired from sediment. For example, aquatic life/fisheries use can be considered impaired if the levels of sediment create conditions where at least one biological assemblage (macroinvertebrate, periphyton, or fishery) is 75% or less of a reference condition.

Also listed as a cause of impairment is pH. The parameter pH is defined as the negative logarithm of the hydrogen-ion activity, with lower pH values reflecting acidic water conditions.

Table 1-2 provides a general summary of each water body including the beneficial uses not fully supported and the specific pollutants requiring TMDL development within this document. Note that a few water bodies are identified as not fully supporting the beneficial uses of agriculture and industry. State water quality standards are protective of multiple uses that always include agriculture and industry for A-1 or B-1 classified streams. The goal is to not only protect these uses within given water bodies, but to also protect these uses in downstream waters. This then ensures a healthy aquatic ecosystem while at the same time keeping pollutant levels low enough to support other existing or potential human related uses such as agriculture or industry. Fortunately, by developing this plan around targets and restoration efforts needed to protect aquatic life and drinking water beneficial uses, both agriculture and industry beneficial uses are also protected since the aquatic life and drinking water uses are more sensitive to the pollutants of concern. This approach also provides protection for the recreation/aesthetics related beneficial use by providing targets that address aesthetic problems that result from metals precipitates and associated turbid waters and stream deposits.

The specific details associated with each water body and the metals and other pollutants that are causing impairment problems are further discussed within Sections 2.0 through 4.0 of this document.

Table 1-1. 303(d) Impaired Water Bodies Listing History (1996, 1998, and 2000) for the Cooke City Area

Water Body Name	Stream Segment Number	Probable Cause (pollutant or pollutant category)	Year(s) Listed
Daisy Creek	MT43C002_140	Metals	1996, 1998, 2000
Daisy Creek	MT43C002_140	pH	1996, 1998
Daisy Creek	MT43C002_140	Sediment (Siltation)	2000
Stillwater River	MT43C001_010	Metals	1996, 1998, 2000
Fisher Creek	MT43D002_110	Metals	1996, 1998, 2000
Fisher Creek	MT43D002_110	pH	1996, 1998, 2000
Clarks Fork of the Yellowstone	MT43D001_020	Metals	1996, 1998, 2000
Clarks Fork of the Yellowstone	MT43D001_020	pH	1996, 1998
Soda Butte Creek*	NA	Metals	1996, 1998
Soda Butte Creek*	NA	Sediment (Suspended Solids)	1996, 1998
Soda Butte Creek (upper)*	MT43B002_032	No impairments	2000
Soda Butte Creek (lower)*	MT43B002_031	Metals	2000
Miller Creek	MT43B002	Metals	Not previously listed

*Soda Butte Creek was divided into two segments for the 2000 list, the upper section from the headwaters to the McLaren Tailings, and the lower section from the McLaren Tailings to the Montana-Wyoming border.

Table 1-2. Water Bodies Needing a Restoration Plan (Cooke City Planning Area)

Water Body	Beneficial Uses not Fully Supported	Watershed	Pollutants
Daisy Creek (headwaters to the mouth at Stillwater River)	Aquatic Life; Cold Water Fish; Drinking Water; Recreation/Aesthetics; Agriculture; Industry	Stillwater River (upper portion)	Metals (Copper, Cadmium, Lead, Zinc, Iron, Manganese, Aluminum); pH; Sediment
Stillwater River (headwaters to Flood Creek)	Aquatic Life; Cold Water Fish; Recreation/Aesthetics	Stillwater River (upper portion)	Metals (Copper, Iron, Manganese); Sediment
Fisher Creek (headwaters to the mouth at the Clarks Fork of the Yellowstone)	Aquatic Life; Cold Water Fish; Drinking Water; Recreation/Aesthetics; Agriculture; Industry	Clarks Fork of the Yellowstone (upper portion)	Metals (Copper, Iron, Manganese, Aluminum, Zinc, Cadmium, Lead, Silver); pH; Sediment
Clarks Fork of the Yellowstone (Fisher Creek to the Montana border)	Aquatic Life; Cold Water Fish; Drinking Water	Clarks Fork of the Yellowstone (upper portion)	Metals (Copper, Zinc, Cadmium, Silver, Iron); pH
Miller Creek (Headwaters to the mouth at Soda Butte Creek)	Aquatic Life; Cold Water Fish, Drinking Water	Yellowstone Headwaters (upper portion)	Metals (Copper, Iron, Cadmium, Lead, Manganese, Zinc)
Soda Butte Creek (McLaren Tailings to the Montana border)	Aquatic Life; Cold Water Fish; Drinking Water; Recreation/Aesthetics	Yellowstone Headwaters (upper portion)	Metals (Copper, Iron, Manganese, Lead, Aluminum)

1.1.2 Water Quality Restoration Plan Organization and Terminology

This plan starts out with this introductory section (Section 1.0) which includes general planning information, a description of the area, and a description of applicable water quality standards. This is then followed by Sections 2.0, which specifically addresses restoration goals and load allocations for Daisy Creek and the portion of the Stillwater River within the Cooke City TMDL Planning Area. Section 3.0 addresses the same information for the Fisher Creek and the portion of the Clarks Fork of the Yellowstone River upstream of the Montana-Wyoming border. Section 4.0 addresses the same information for Miller Creek and the portions of Soda Butte Creek within Montana. Section 5.0 provides information on the overall implementation strategy for planned restoration work, including a water quality monitoring plan. Section 6.0 addresses stakeholder and public participation. The plan is written in a manner that someone only interested in Daisy Creek and/or the Stillwater River could just read Sections 1, 2, 5 and 6. In the same manner, someone only interested in Fisher Creek and/or the Clarks Fork River need only read Sections 1,3, 5 and 6, and someone only interested in Miller Creek and/or Soda Butte Creek need only read Sections 1, 4, 5 and 6.

Throughout this document, the term restoration is used in a broad sense that includes water quality improvements realized through activities referred to as restoration or otherwise referred to as cleanup, remediation, treatment, or source control. These water quality improvements include a broad consideration of improvements to the chemical, physical, and/or biological components of the system. Note that water quality improvements address more than just a consideration of water column chemistry.

The term pollutant is associated with the "cause" of a water quality impairment as used for 303(d) listing purposes.

Natural background is a commonly used term in this document. Natural background conditions can often be a significant source for some pollutants and should be taken into account for determining baseline conditions. Natural background loading does not include the accelerated transport of pollutants to a receiving water body from processes such as increased erosion, increased ground water flow, or increased surface or ground water exposure to metal-bearing materials, if the accelerated transport or exposure is caused by human activities. This is true even if the pollutant occurs naturally in soils or rock materials

1.2 Area and Water Body Characterization

This section describes many of the physical and environmental characteristics associated with the water bodies of concern and subsequent water quality restoration planning.

1.2.1 Location and Land Use

The Cooke City Planning Area is located in the southern portion of Montana just north of the Montana-Wyoming border and northeast of Yellowstone National Park, including a small portion of the park. As previously discussed, it includes the headwaters of river systems that all eventually flow into the Yellowstone River. The three river systems are the Clark's Fork of the Yellowstone, the Stillwater, and the Lamar. Soda Butte Creek flows into the Lamar River, both of which flow through Yellowstone National Park. Other significant tributary streams in the area include Daisy, Miller, Fisher, Goose, Sheep, Lady of the Lake, Republic, and Woody Creeks (Figure E-2).

Figure 1-1 is a map showing land ownership information for the area. Much of the area falls within the boundaries of the Gallatin and the Custer National Forests, some of which includes portions of the Absaroka-Beartooth Wilderness Area. To the south is the Montana-Wyoming state line and public lands administered by the Shoshone National Forest.

Figure 1-2 is a map showing land use/cover in the area of interest. Forest, shrubland, and transitional areas (from fairly recent fires) cover most of the drainage area. The area includes portions of Park, Sweet Grass, and Stillwater Counties in Montana. All impaired water bodies are located within Park County except for a lower section of the Stillwater River located within the southern portion of Stillwater County, although all significant sources and associated restoration planning activities are within Park County.

The communities of Cooke City and Silver Gate, Montana are the only population centers in the area. The neighboring communities of Mammoth, Wyoming and Gardiner, Montana are located about 50 miles to the west. Red Lodge, Montana is about 65 miles to the northeast, via the Beartooth Highway, and Cody, Wyoming is located 60 miles to the southeast.

The drainage areas of concern are located at elevations that range from over 10,000 feet above sea level in the upper reaches to approximately 7400 to 8000 feet in the lower reaches. Much of the area is therefore snow-covered for a significant portion of the year. The topography of the area is mountainous, with the dominant topographic features created by glaciation. The stream valleys are U-shaped and broad while the ridges are steep, rock covered, and narrow. Much of the area is located at or near tree line, especially in the Fisher Mountain area where many of the major mining disturbances are located.

1.2.2 Climate

The Cooke City Planning Area has a continental climate modified by the mountain setting. The area is characterized by large daily and annual temperature ranges and marked differences in precipitation, temperature, and wind patterns over distances of only a few miles.

Precipitation and temperature data have been collected periodically at Cooke City from 1967 through 1995. The Cooke City station is located at an elevation of 7,460 feet. The average annual precipitation for the period of record is 25.38 inches. Temperatures are coldest in January with an average minimum of 2.4ºF and an average maximum temperature of 23.3ºF. Temperatures are warmest in July with an average minimum temperature of 37.9ºF and an average maximum temperature of 73.1ºF. Precipitation and temperature vary with elevation, and freezing conditions can occur any day of the year.

Precipitation records from a Soil Conservation Service SNOTEL station (SCS Station TX06) at an elevation of 9,100 feet in the Fisher Creek drainage indicate that the average annual precipitation at this location is 60 inches, most of which occurs as snowfall. Fifty percent of the annual precipitation occurs between October and February, with January being the highest average precipitation month (14.4 percent) and August having the lowest average monthly precipitation (3.9 percent) (URS, 1998). Average annual snowfall at higher elevations is about 500 inches.

1.2.3 Hydrology

Surface water discharge in the area is quite variable and seasonally dependent. The watersheds tend to show rapid flow response to snowmelt and summer precipitation events. Significant diurnal variations occur particularly during the peak snowmelt periods. The upper drainage basins are geomorphically similar and relatively small in aerial extent. The following sections provide specific hydrology information, much of it based on information at sampling locations referenced throughout this document and shown in Figure 1-3.

1.2.3.1 Hydrology of Daisy Creek and the Upper Portion of the Stillwater River

The Daisy Creek drainage basin collects water from the north side of Daisy Pass, the north flank of Crown Butte, the west flank of Fisher Mountain, and from the historic McLaren open pit mining operation. Daisy Creek flows northward from its origin below Daisy Pass approximately two miles to its confluence with the Stillwater River, which continues generally northward through the Absaroka-Beartooth Wilderness Area. Elevation of the headwaters is about 9,400 feet, dropping to 8,500 feet at the confluence of Daisy Creek and the Stillwater River. Near the headwaters of Daisy Creek, streamflow measurements at DC2 have ranged from less than 0.2 to 15 cfs based on database information available on a Maxim Technologies, Inc website (Maxim, 2001a). Farther downstream, flows in Daisy Creek have ranged from less than 0.3 to 57 cfs.

Several large springs and tributaries, including Daisy Creek, form the headwaters of the Stillwater River. Streamflow measurements upstream of the wilderness boundary at SW7 have ranged from 1.5 to 223 cfs.

1.2.3.2 Hydrology of Fisher Creek and the Upper Portion of the Clarks Fork of the Yellowstone

Fisher Creek drains the south side of Lulu Pass, the east flanks of Fisher and Henderson Mountains, and the west flanks of Scotch Bonnet and Sheep Mountains. Fisher Creek flows generally to the southeast for approximately 3.5 miles to its confluence with the Clarks Forks River. Flows in the upper portion of Fisher Creek at site SW3 have ranged from 0.2 to 18 cfs. Farther downstream, flows in Fisher Creek at site SW4 have ranged from 0.4 to 112 cfs (Maxim, 2001a).

Fisher Creek and the Lady of the Lake Creek combine to form the Clarks Fork River. Flows downstream of this location at site SW6 have ranged from 1 to 273 cfs (Maxim, 2001a). Farther downstream, the Broadwater River joins the Clarks Fork upstream of the Montana - Wyoming border and significantly increases streamflow.

1.2.3.3 Hydrology of Miller Creek and Soda Butte Creek

Miller Creek drains the south side of Daisy Pass, the west flank of Henderson Mountain, and the east flank of Miller Mountain. The headwaters are about 9,400 feet in elevation, dropping to 7,600 feet at the Soda Butte Creek confluence. Miller Creek flows southeastward for approximately two miles to its confluence with Soda Butte Creek just upstream of where Soda Butte Creek flows through Cooke City. Flows in Miller Creek at site SW2 have ranged from less than 0.5 to 49 cfs (Maxim, 2001a). During very dry conditions, Miller Creek will no longer flow above its confluence with Soda Butte Creek.

Soda Butte Creek has its headwaters near Colter Pass about 1 mile east of Cook City. Just below Miller Creek and the McLaren Tailings, flows in Soda Butte Creek have ranged from 14 to 101 cfs (Maxim, 2001a). Farther downstream, Woody Creek flows into Soda Butte Creek and provides about 70 percent of the total flow prior to Soda Butte Creek entering Wyoming and Yellowstone National Park, where flows are significantly greater.

1.2.4 Fish Habitat and Aquatic Life

The *New World Project 3rd Preliminary Review Draft Environmental Impact Statement* (Draft EIS, 1996) contains considerable detail concerning aquatic life habitat conditions within Chapter 8 of the document. Below is some summary information concerning fish habitat, and aquatic macroinvertebrates from the above referenced document.

Both Daisy Creek and the Upper Stillwater River are naturally void of fish due to barrier falls in the Stillwater River just upstream of the Goose Creek confluence. The upper portion of the Stillwater River above the Daisy Creek confluence does, however, support a relatively abundant and diverse macroinvertebrate community containing numerous sensitive taxa. Downstream from Daisy Creek, the macroinvertebrate community declines substantially until near Goose Creek where it begins to improve. The macroinvertebrate community is under severe stress in Daisy Creek.

The upper reaches of Fisher Creek have limited fish habitat, with increasing pool frequency, habitat complexity and other indicators of suitable conditions for fry, juvenile and adult fish in the middle to lower reaches. The upper reaches of the Clarks Fork have high quality pools formed by either large boulders or woody debris and other indicators of suitable habitat for fish. Aquatic macroinvertebrates in the upper reaches of Fisher Creek reflect stressed conditions, with partial recovery farther downstream. The Clarks Fork data suggests a trend of improved conditions as you move downstream and where there is less influence from Fisher Creek.

Miller Creek may be naturally void of fish due to high gradients and a waterfall in the lower reaches preventing upstream migration of fish into the stream. Nonetheless, habitat conditions in the watershed are sufficient for a small resident salmonid fishery to exist. Aquatic macroinvertebrate communities include sensitive species indicating better health than some of the other streams impacted by metals in the area.

The lower portion of Soda Butte Creek within Yellowstone National Park supports a popular stream fishery. Within Montana, the Soda Butte fishery is limited. The very upper reach of Soda Butte Creek has limited fish habitat, with improved conditions downstream of the McLaren Tailings and below the Woody Creek confluence. Extremely high levels of fine sediment, primarily associated with natural conditions, enter and deposit in Soda Butte Creek via Woody Creek. Although this sediment deposition has the ability to limit fish reproduction, the overall lack of suitable habitat may be more of a limiting factor for trout. Aquatic macroinvertebrate communities include sensitive species indicating better health than some of the other streams impacted by metals in the area, although diversity and abundance are reduced in an area downstream of the McLaren Tailings. Macroinvertebrates collected in Soda Butte Creek downstream of the McLaren Tailings have been shown to have elevated whole-body concentrations of metals. Additional studies have also shown elevated levels of metals, including copper, in fish in Soda Butte Creek below the McLaren Tailings (Peterson and Boughton, 2000)

1.3 Background Information

This section describes some of the historical context associated with mining activities in the area and efforts to address water quality restoration.

1.3.1 New World Mining District

All water bodies addressed by this document are streams or stream segments that either fall within or are in close proximity to the boundaries of the New World Mining District (District) as shown by Figure 1-4. The District, which includes a mixture of National

Forest and private lands, is a historic metals mining area generally located near Cooke City, Montana in the Beartooth Mountains. This historic mining district contains hard rock mining wastes and acid discharges that impact the environment. Human health and environmental issues are related to elevated levels of metals present in mine wastes, open pits, acidic water discharging from mine openings, and stream sediments.

On August 12, 1996, the United States signed a Settlement Agreement (Agreement) with Crown Butte Mining, Inc. (CBMI) to purchase CBMI's interest in their District holdings. This transfer of property to the U.S. government effectively ended CBMI's proposed mine development plans and provided $22.5 million to clean up historic mining impacts on certain properties in the District. In June 1998, a Consent Decree (Decree) was signed by all interested parties and CBMI and approved by the United States District Court. The Decree finalized the terms of the Agreement and made available the funds that will be used for mine cleanup. Monies available for cleanup are to be first spent on District Property, which, as defined in the Decree, includes all property or interests in property that CBMI relinquished to the United States. As funds are available after District Property is cleaned up to the satisfaction of the United States, other mining disturbances, such as the McLaren Tailings, in the area will be addressed. **It is important to note that the District encompasses a large area of about 40 square miles, but District Property is limited to certain holdings within the overall District (Figure 1-4).**

Historic mining disturbances on District Property are about 50 acres in size according to recent measurements made by the USDA-FS Interagency Spatial Analysis Center. The McLaren Tailings Area, including the McLaren Mill Site, covers an additional 12 acres on non-District Property.

The New World Mining District Response and Restoration Project: Project Summary, 2001(Maxim, 2001b) provides a relatively short and informative overall description of the area and associated mining impacts. It also describes the restoration planning and implementation process for the District. In addition, Maxim Technologies, under contract through the USFS, maintains a website at http://www.maximtechnologies.com/newworld/ (Maxim, 2001a) that includes a comprehensive database of water quality sampling results for all water bodies of interest in the Cooke City TMDL Planning Area. This database includes information from numerous historical and recent sampling events. The website also includes many of the reports referenced within this restoration plan. The USFS also provides a link to this website via http://www.fs.fed.us/r1/gallatin/main/index.shtml.

Impairment conditions associated with Daisy Creek, the Stillwater River, Fisher Creek, the Clarks Fork of the Yellowstone, and Miller Creek are mainly addressed via District activities. Therefore, planning information for these water bodies, as found within this document, closely parallel District efforts.

1.3.2 Soda Butte Creek

Soda Butte Creek impairment conditions are only partly addressed, at least at this time, via District cleanup commitments. This includes potential reductions in metal loads via cleanup efforts in the Miller Creek drainage. It also includes the possibility that District efforts could address the McLaren Tailings and other mining disturbances impacting Soda

Butte Creek if funding exists once all other District responsibilities are addressed (Maxim, 2001b). Otherwise, the McLaren Tailings will need to be addressed via some other yet-to-be-addressed approach. Some of the additional metal sources to Soda Butte Creek are within the Republic/Woody Creek and other tributary drainage areas. Some of the needed restoration efforts are currently being pursued as further discussed in Chapters 4 and 5. For example, the MDEQ is currently working with other stakeholders on efforts to characterize and mitigate environmental impacts associated with some of the historical mining in the Republic/Woody Creek drainage and is also working on a solution for the McLaren Tailings. These and other restoration efforts for the Soda Butte Creek drainage are further discussed in Chapters 4 and 5.

1.4 Water Quality Standards

This section describes the applicable water quality standards for the water bodies within the Cooke City TMDL Planning Area. These standards provide the basis for 303(d) listing decisions as well as the basis for setting restoration goals.

1.4.1 Water Body Classifications and Beneficial Uses

The Montana Surface Water Quality Standards and Procedures (Water Quality Standards: Title 17, Chapter 30, Sub-Chapter 6) are a part of the Administrative Rules of Montana. Per the Water Quality Standards, all water bodies in the Cooke City Planning Area are classified as B-1 (17.30.611) except for the section of the Stillwater River, which falls within the boundaries of the Absaroka-Beartooth Wilderness, and the Montana portions of Soda Butte Creek located within Yellowstone National Park (Figure E-2). These sections are classified as A-1 (17.30.614). The Montana portions of Soda Butte Creek located within Yellowstone National Park are also identified as an “outstanding waters”, and a section of the Clarks Fork within Wyoming is included within the National Wild and Scenic Rivers System.

1.4.2 Numeric and Narrative Standards

There are several sections within the Water Quality Standards that are applicable to water bodies classified as either A-1 or B-1 and also applicable to water quality restoration and TMDL development in the Cooke City TMDL Planning Area. Several of these sections are identified below, with the relevant wording from each section quoted. In addition, the pollutants of concern associated with the specific section and the water bodies of concern are also listed. Where A-1 and B-1 standards are the same, it is noted.

17.30.623(1):

"*Waters classified B-1 are suitable for drinking, culinary and food processing purposes, after conventional treatment; bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply*."

Pollutants: All

17.30.622:

(1) "*Waters classified A-1 are suitable for drinking, culinary and food processing purposes after conventional treatment for removal of naturally present impurities."*

(2) *"Water quality must be suitable for bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply*."

Pollutants: All

17.30.623(2) and 17.30.622(3): [Applies to B-1 and A-1 classifications]

"*No person may violate the following specific water quality standards for waters classified B-1 (A-1 for 17.30.622(3)):"* Relevant specific standards are discussed below:

17.30.623(2)(c) and 17.30.622(3)(c): [Applies to B-1 and A-1 classifications]

"*Induced variations of hydrogen ion concentration (pH) within the range of 6.5 to 8.5 must be less than 0.5 pH unit. Natural pH outside this range must be maintained without change. Natural pH above 7.0 must be maintained above 7.0*."

Pollutants: pH

17.30.623(2)(d): [Applies to B-1 classification only]

"The maximum allowable increase above naturally occurring turbidity is 5 nephelometric turbidity units except as permitted in ARM 17.30.637."

Pollutants: Sediment (suspended solids); Metals (suspended precipitants)

17.30.622(3)(c): [Applies to A-1 classification only]

"No increase above naturally occurring turbidity is allowed except as permitted in ARM 17.30.637."

Pollutants: Sediment (suspended solids); Metals (suspended precipitants)

17.30.623(2)(f) and 17.30.622(3)(f): [Applies to B-1 and A-1 classifications]

"*No increases are allowed above naturally occurring concentrations of sediment, settleable solids, oils, or floating solids, which will or are likely to create a nuisance or render the waters harmful, detrimental, or injurious to public health, recreation, safety, welfare, livestock, wild animals, birds, fish, or other wildlife*."

Pollutants: Sediment (suspended solids)

17.30.623(2)(h)(i) and 17.30.622(3)(i): [Applies to B-1 and A-1 classifications]

"*Concentrations of carcinogenic, bioconcentrating, toxic or harmful parameters which would remain in the water after conventional water treatment may not exceed the applicable standards set forth in department Circular WQB-7*"

Pollutants: Metals, specifically numeric standards for Cadmium, Copper, Iron, Lead, Manganese, and Zinc. No distinctions between an A-1 or B-1 classification exist for these parameters.

17.30.637(1): [This is from a section of the water quality standards applicable to all water bodies including those classified as either B-1 or A-1]

"*State surface waters must be free from substances attributable to municipal, industrial, agricultural practices or other discharges that will:*

17.30.637(1)(a): [Applies to B-1 and A-1 classifications]
"*settle to form objectionable sludge deposits or emulsions beneath the surface of the water or upon adjoining shorelines;*"
Pollutants: Sediment and Metals (Precipitates)

17.30.637(1)(d): [Applies to B-1 and A-1 classifications]
"*create concentrations or combinations of materials which are toxic or harmful to human, animal, plant or aquatic life;*"
Pollutants: All

17.30.602 Definitions:

17.30.602 (17): [Applies to B-1 and A-1 classifications]
"Naturally occurring" means conditions or material present from runoff or percolation over which man has no control or from developed land where all reasonable land, soil and water conservation practices have been applied. Conditions resulting from the reasonable operation of dams in existence as of July 1, 1971 are natural.
Pollutants: All

17.30.602(21): [Applies to B-1 and A-1 classifications]
"Reasonable land, soil, and water conservation practices" means methods, measures, or practices that protect present and reasonably anticipated beneficial uses. These practices include but are not limited to structural and nonstructural controls and operation and maintenance procedures. Appropriate practices may be applied before, during, or after pollution-producing activities.
Pollutants: All

Note that the standards of interest are nearly identical for B-1 and A-1 classified streams. An A-1 classification has stricter protection requirements associated with allowable levels of impurities for drinking, culinary and food processing purposes (Section 17.30.622) and stricter protection requirements associated with allowable levels of turbidity (Section 17.30.622(3)(c)). In reference to the A-1 sections of each stream, strict upstream targets have been incorporated into this plan to address the sediment in the Stillwater River and metals loading and potentially associated turbid conditions in both the Stillwater River and Soda Butte Creek. It is believed that these targets will be protective of both the A-1 and B-1 classified sections of these water bodies.

Also note that the term “naturally occurring” is not the same as “natural background” as used in the plan per Section 1.1.2. “Naturally occurring” can incorporate some limited level of human influence under conditions where reasonable land, soil, and water conservation practices are applied whereas “natural background” is not intended to incorporate any human influences.

An important consideration within WQB-7 is the fact that the numerical standards associated with aquatic life protection for several metals (copper, cadmium, zinc, silver, and lead) are a function of water hardness. As hardness decreases, the applicable numeric standard for these metals decreases resulting in more stringent water quality protection requirements to protect aquatic life. For all water bodies in this WQRP, water hardness decreases with increasing flow, resulting in lower applicable standards. Because of this, water quality standards and associated restoration targets are identified for both low and high flow conditions in order to estimate the total range for restoration planning purposes. In general, the low flow values are based on hardness during flows typically experienced before and after spring runoff (late July through May), and the higher flow values are based on hardness during flows typically experienced during spring runoff (June through mid July). Estimates toward the low end of the hardness range are used to provide a conservative approach toward the application of standards.

Throughout this plan, several targets (reference Table E-2) are based on biota indicators being at or greater than 75% of a desired or reference condition. The 75% is directly from *Appendix A of Water Quality Assessment Process and Methods* (MDEQ, 2000). This number represents an interpretation of narrative standards, particularly those standards based on harmful conditions to aquatic life. Where any biota indicator is below 75% of reference, the stream is considered moderately impaired, and if the indicator is below 25%, the stream is considered non-supporting. Minor impairment is a situation where all biota indicators are greater that 75% of reference but still showing some negative impact(s). A stream is considered fully supporting of its beneficial uses where there is no impairment or only minor impairment. This approach recognizes that a stream where all biota indicators are at or above 75% can support a fully functioning aquatic community while also recognizing the variations in measurement methods and variations between streams that would make it difficult to justify the use of higher percentages. The approach takes into account the fact that limited minor impacts to a water body do not necessarily represent a violation of Montana's water quality standards, although they still may represent opportunities for water quality improvements. Where direct measures of biota are not available, the 75% approach is sometimes applied to habitat indicators, as is the case for the sediment targets associated with pebble counts in this plan.

Montana State law for outstanding waters (Montana Water Quality Act; Section 75-5-316) focuses on the need to prevent any new point or nonpoint sources from causing significant degradation, with focus on limiting impacts from toxic and other health related pollutants. The contaminant sources of concern, as identified within this document, are associated with existing nonpoint sources and cleanup of such sources. The outstanding resource designation appears to have no bearing on existing or proposed future activities within the Cooke City Planning Area, and restoration activities discussed within this plan are consistent with the outstanding waters designation that applies to portions of Soda Butte Creek.

1.4.3 Temporary Standards

Title 75, Chapter 5, Section 312 (ARM 75-5-312) of the Montana Water Quality Act allows for the temporary modification of water quality standards via the Board of Environmental Review (Board). This applies to a specific water body or segment on a parameter-by-parameter basis in those instances in which substantive information indicates that the water body or segment is not supporting its designated uses. When the Board adopts temporary standards, the goal is to improve water quality to the point at which an additional beneficial use or uses are supported. As a condition of establishing temporary water quality standards, an implementation plan is required for use by the Board in determining whether to adopt a proposed temporary water quality standard. This petition must specifically describe the affected state water, the existing ambient water quality for the parameter or parameters at issue, the water quality standard or standards affected, and the temporary modification sought. Additional information includes an implementation plan to eliminate the water quality limiting factors to the extent considered achievable as well as a schedule for implementing the plan.

Section 312 goes on to require that the DEQ report to the Board at least once every three years regarding whether adequate efforts have been made to implement the plans submitted as the basis for the temporary standard. The Board then reviews the temporary standards and has the option of terminating the temporary standard or modifying the existing plan associated with the temporary standards. Termination can be based on improvements in water quality to where beneficial uses are supported, reclassification, or failure to implement the plan according to the plan's schedule.

Temporary standards are currently in place for three water bodies (Daisy Creek, Stillwater River, and Fisher Creek) within the New World Mining District (Section 17.30.630.1). The standards became effective on June 4, 1999 and are in effect until June 4, 2014. These standards were adopted in response to a "petition report" (Stanley, 1999) submitted by Crown Butte Mines, Inc. (CBMI). This petition report is entitled *Support Document and Implementation Plan Submitted by Crown Butte Mines, Inc. in Support of its Petition for Temporary Modification of Water Quality Standards for Selected Parameters for Fisher and Daisy Creeks and a Headwater Segment of the Stillwater River, Park County, Montana*. This reference document will be referred to as the *Petition Report* throughout this document. Temporary standards do not apply to the Clark Fork of the Yellowstone, Miller Creek, Soda Butte Creek, or the A-1 classified section of the Stillwater River.

The goal for the water bodies with temporary standards is stated under 17.30.630.(1)(a) as: "(t)he goal of the state of Montana is to have these water bodies support the uses listed for waters classified B-1 at ARM 17.30.623(1)." The temporary numeric standards apply to water quality extremes (mean plus two standard deviations) associated with existing water quality conditions prior to any cleanup efforts. The purpose of these temporary standards is to effectively insulate the responsible party from legal enforcement actions during a cleanup phase as defined by the time period during which the standards apply. The responsible party is still responsible for performing cleanup activities in a manner consistent with the overall work plan and commitments within the *Petition Report* as discussed above. The numeric values associated with the temporary standards in no way represent any existing or future water quality restoration goals. They instead help define a process to proceed with water quality restoration efforts in situations such as those found in the New World Mining District. The goal of having the water bodies support the uses listed for waters classified B-1, as stated at the beginning of this paragraph, is the primary goal for the streams with temporary standards as well as other water bodies addressed in this water quality restoration plan (unless otherwise classified as A-1).

SECTION 2.0
DAISY CREEK AND STILLWATER RIVER WATER QUALITY RESTORATION

2.1 Impairment Conditions

Daisy Creek and the Stillwater River are both severely impacted from elevated metals concentrations. Daisy Creek also has low pH values, and both streams are impacted from sediment deposits. Many reports and data sources identify impacts to beneficial uses. Section 2.1.1 below provides impairment details associated with metals and pH, and Section 2.1.2 provides impairment details associated with sediment.

2.1.1 Metals and pH

The *Petition Report* (Stanley, 1999) for temporary standards includes water quality data tables for Daisy Creek and the Stillwater River. Included in the data tables are statistical summaries of the analytical data from 1989 through 1998. Another report, entitled *Quantification of Metal Loads by Tracer Injection and Synoptic Sampling in Daisy Creek and the Stillwater River, Park County, Montana, August 1999* (Nimick and Cleasby, 2001), provides sample results at numerous locations along Daisy Creek and the Stillwater River during a relatively low flow period. In addition, the Maxim website (Maxim, 2001a) provides significant water quality and sediment metals concentration data. Additional sediment metals concentration data are also available based on work done to support restoration efforts (Camp, Dresser and McKee, 1997).

The above referenced information and other reports show that conditions in Daisy Creek do not fully support the beneficial uses associated with a B-1 classification and do not comply with applicable B-1 standards for copper, cadmium, lead, zinc, iron, manganese, and pH. Also, metals and pH values are such that the water body would not be able to support any agriculture or industry uses associated with a B-1 classification.

The above referenced information and other reports show that conditions in the Stillwater River below Daisy Creek do not fully support the beneficial uses associated with a B-1 or A-1 classification and do not comply with applicable B-1 or A-1 standards for copper, iron, and manganese.

In addition to elevated metal concentrations in water, metals precipitate and settle to form objectionable sludge deposits in both water bodies, and colloidal particles associated with metal precipitates result in high turbidity conditions that may not be supportive of narrative standards in the Stillwater River below Daisy Creek. The objectionable sludge layer is apparently composed of colloidal particles, metallic precipitates (primarily aluminum and iron), algae, bacteria, and organic matter from dead algae and bacteria. Periphyton and bacteria colonize most of this layer and produce gas bubbles from respiration. Many or most of these bubbles become entrapped in this layer, resulting in a soft and porous sludge that is present late summer and perhaps other low flow periods. These deposits and associated turbidity from metal precipitates also negatively impact the aesthetics of both water bodies.

Tables 2-1 and 2-2 provide summaries of the impairment concerns associated with metals and pH. All metal concentrations are total recoverable unless otherwise noted. The metals concentrations and pH values are from Daisy Creek sampling location DC5, and Stillwater River sampling location SW7. The Daisy Creek sample location DC5 is downstream of mining impacts and provides representation of the significant mining impacts to water quality not only to Daisy Creek but also to the Stillwater River. The Stillwater River sample location SW7 represents water quality just upstream of the wilderness boundary. Both sampling locations, which are shown in Figure 1-3, are routinely used to track water quality in this stream and to measure progress of ongoing restoration efforts. As expected, metal concentrations in the Stillwater River are significantly lower than in Daisy Creek since Daisy Creek flows into the Stillwater River and essentially all significant contaminant sources are in the Daisy Creek drainage. In fact, values are low enough for some metals such that the concentrations are below water quality standards, meaning that a TMDL is not necessary for that particular metal in the Stillwater River.

For the section of the Stillwater River above Daisy Creek, sampling results (Maxim 2001a) and efforts to identify potential sources of metals show that there are probably not any impairment conditions associated with metals, pH or other pollutants in this stream segment. TMDL development is, therefore, not pursued for this stream segment.

Appendix B provides a descriptive water quality summary for each of the metals of concern and pH as they relate to impairment determinations.

2.1.2 Impairment Conditions Associated with Sediment

Eroded soils and metal precipitates create impairment conditions due to their resulting deposition in the streambed. This discussion focuses on impairment conditions associated with eroded soils, although it is recognized that these eroded soils may also transport metal contaminants. It is also further recognized that precipitation of metals on the streambed can confound efforts to measure sediment impacts and that these precipitates can negatively impact aquatic life in a manner similar to sediment impacts.

A final technical memorandum entitled *New World Response and Restoration Project Final 2000 Aquatic Monitoring Results* (Maxim, 2000) provides a summary of historical aquatic assessment results as well as more recent data for Daisy Creek and the Stillwater River below Daisy Creek. The previously referenced Draft EIS also provides information concerning sediment and habitat conditions, including modeled sediment yield information. Both reports indicate habitat concerns associated with sediment indicators such as embeddedness and percent fines.

The USFS has calculated and recently updated the modeled sediment yield information for Daisy Creek (discussions with Mark Story, USFS). The modeled results show that on an annual basis, there is a greater than 50% yield above natural background for Daisy Creek. This additional yield in sediment also impacts the Stillwater River below Daisy Creek where much of the sediment is deposited.

Table 2-1. Daisy Creek Metals and pH Impairment Summary

Pollutant	Sampling Results	Water Quality Standard Concern	Water Quality Standards Reference(s)
Copper	346 – 2850 ug/l	- consistently > 5.2 ug/l chronic aquatic life (high flow)[1] - consistently > 7.3 ug/l chronic aquatic life (low flow)[1] - consistently > 7.3 ug/l acute aquatic life (high flow)[1] - consistently > 10.7 ug/l acute aquatic life (low flow)[1] - often > 1300 ug/l human health - results in elevated copper levels in sediment	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d)
Iron	2380 – 6880 ug/l	- consistently > 1000 ug/l chronic aquatic life - consistently > 300 ug/l domestic use - consistently forms objectionable sludge deposits	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(a) 17.30.637(1)(d) 17.30.623(2)(d)
Manganese	14 – 1230 ug/l	- consistently > 50 ug/l domestic use	17.30.623(2)(h)(i) - WQB-7
Aluminum	40 – 300 ug/l (dissolved) 1400 - 8100 ug/l (total recoverable)	- consistently > 87 ug/l aquatic life for dissolved aluminum (chronic at pH 6.5 to 9.0; but high values only occur at pH values less than 6.5) - consistently forms objectionable streambed deposits - consistently produces high turbidity from metal precipitates	17.30.637(1)(a) 17.30.623(2)(d)
Zinc	60 – 420 ug/l	- consistently > 67 ug/l chronic & acute aquatic life (high flow)[1] - consistently > 94 ug/l chronic & acute aquatic life (low flow)[1]	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d)
Cadmium	< 1 – 2.85 ug/l	- often > 0.16 chronic aquatic life (high flow)[1] - often > 0.22 ug/l chronic aquatic life (low flow)[1] - sometime > 1.0 ug/l acute aquatic life (high flow)[1] - sometimes > 1.6 ug/l acute aquatic life (low flow)[1]	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d)
Lead	< 1 – 3 ug/l	- sometimes > 1.3 ug/l chronic aquatic life (high flow)[1] - sometimes > 2.2 ug/l chronic aquatic life (low flow)[1] - results in elevated lead levels in sediment	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d)
pH	5.3 – 7.7	- below naturally occurring levels during much of the year - contributes to metals solubility and resulting precipitation problems	17.30.623(2)(c) 17.30.637(1)(d)

Notes:
1. Standards reflect adjustments for water hardness, which varies during lower flow periods (generally before and after runoff) and higher flow periods (generally during late spring and early summer runoff) in Daisy Creek; the low flow hardness value used for Daisy Creek is 75 mg/l as calcium carbonate; and the higher flow hardness value is 50 mg/l as calcium carbonate.

Table 2-2. Stillwater River (Below Daisy Creek) Metals Impairment Summary

Pollutant	Sampling Results	Water Quality Standard Concern	Water Quality Standards Reference(s)
Copper	Below Detection - 210 ug/l	- consistently > 5.2 ug/l chronic aquatic life (high flow) [1] - consistently > 7.3 ug/l chronic aquatic life (low flow) [1] - consistently > 7.3 ug/l acute aquatic life (high flow) [1] - consistently > 10.7 ug/l acute aquatic life (low flow) [1] - results in elevated copper levels in sediment	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d)
Iron	70 – 1200 ug/l	- sometimes > 1000 ug/l aquatic life (chronic) - consistently > 300 ug/l domestic use - consistently forms objectionable sludge deposits (near Daisy Creek confluence)	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(a) 17.30.637(1)(d)
Manganese	Below Detection - 80 ug/l	- often > 50 ug/l domestic use	17.30.623(2)(h)(i) - WQB-7
Aluminum	Below Detection (dissolved) 20 – 600 (total recoverable)	- consistently produces high turbidity from metal precipitates (near Daisy Creek confluence)	17.30.623(2)(d)

Notes:
1. Standards reflect adjustments for water hardness, which varies during lower flow periods (generally before and after runoff) and higher flow periods (generally during late spring and early summer runoff) in the Stillwater River; the low flow hardness value used for the Stillwater River is 75 mg/l as calcium carbonate; and the higher flow hardness values is 50 mg/l as calcium carbonate.

Subsequent field visits by MDEQ water quality specialists during September 2001 further verify impairment conditions. Figure 2-1 shows percent fines curves in Daisy Creek just upstream from the confluence with the Stillwater River and the Stillwater River above and below Daisy Creek (reference Figure 1-3 for the general location of these sediment sample sites). These curves represent the results from Wolman Pebble Counts. For the section of the Stillwater River just below Daisy Creek, the measurements were made by reaching through the floc/bio layer of metal precipitates. Note that current percent fines conditions for Daisy Creek and the Stillwater River below Daisy Creek indicate a relatively large percentage of fine material in comparison to the upper portion of the Stillwater River. This fine material is considered harmful to aquatic life.

Although sediment has not been a listed pollutant (probable cause) for impairment in the Stillwater River, it is addressed as a cause of impairment within this document for the section of the Stillwater River below Daisy Creek only. This is convenient since a significant portion of sediment loading comes from the Daisy Creek drainage where much of the sediment load is being addressed as part of the New World Mining District cleanup effort.

In 2001, MDEQ water quality specialists performed a field investigation of the section of the Stillwater River above Daisy Creek and concluded that any potential sources of sediment would be almost exclusively due to natural background conditions and that there were not any habitat parameters indicating impairment conditions for this portion of the river, making it a reasonable reference stream candidate.

2.2 Source Characterization

2.2.1 Source Inventory

Mining disturbances primarily associated with historical adits and waste rock represent the sources of increased metals and pH conditions due to human activities in the Daisy Creek and Stillwater River drainage areas. Figure 2-2 shows the locations of identified mining disturbances, with the McLaren Pit and associated disturbances from this mine site representing the most significant mining related sources of metals and pH lowering constituents. These same mining disturbances, along with the existing and historic road network and trails shown by Figure 2-3, represent the primary sources of increased sediment loads from human activities. This increased loading of sediment from erosion also represents a potential pathway for metal contaminants located in the soils or along eroding streambanks, although not all eroded soils will necessarily be associated with increased metal transport.

Forest, high elevation shrubland, and rock cover most of the remaining drainage area (Figure 1-2). Therefore, there appears to be a low probability of any other human related sources that could represent significant loading for any of the pollutants of concern. In addition, neither of the impaired water bodies or their tributaries receive point source discharges regulated by a Montana Pollutant Discharge Elimination System permit, meaning that waste load allocations are not necessary for these water bodies.

2.2.2 Metals and pH Source Assessment

As previously discussed, higher metal concentrations in Daisy Creek generally occur during low flow periods when metals loading is predominately transported via acidic ground water discharging directly to Daisy Creek or discharging to springs which run into Daisy Creek and subsequently flow to the Stillwater River. In the upper headwaters pH values are initially greater than 7, then greatly decrease where most of the metal loading occurs, and then consistently increase in the downstream direction along Daisy Creek to the point where pH is no longer of concern within the Stillwater River. This increase in pH promotes the precipitation of metals, which subsequently settle to the bed of Daisy Creek or the Stillwater River and ultimately result in reduced water column concentrations (and perhaps increased concentrations of metals in sediments) in a downstream direction during low flow conditions. Metals concentrations within the Stillwater River decrease even further in a downstream direction due to additional dilution from tributaries and probable additions of clean sources of ground water. In fact, the dilution of metal concentrations is such that higher values are often seen during higher flow events in the lower portions of the Stillwater River (such as sample location SW7) presumably due to the re-suspension of metal precipitates with possible contributions from eroded sediments with attached metal contaminants.

The Nimick and Cleasby (2001) metals loading report provides source information, during a relatively low flow time of year, on a subreach by subreach scale, looking at both surface inflows and subsurface inflows. Appendix B is an excerpt from Nimick and Cleasby that includes a discussion on metal sources and the overall study summary and conclusions. This information provides a good discussion of loading uncertainties as they relate to the study results. Table 2-3 presents loading results information for copper from this report. Similar patterns of loading would be expected for all metals of concern and constituents contributing to pH impairments, as evident by comparisons of the "cumulative load" versus "distance downstream" plots within the referenced report. Though Table 2-3 provides a good summary of relative inputs by location and by pollutant pathway, there is still significant uncertainty and debate as to what portions of these metal loads are from historical mining or natural background. The data does not clearly distinguish between natural background loads and mining related loads. Some of the loading sources such as the moraine or landslide hill, the manganese bog, and the area north and west of the McLaren Mine may eventually prove to be indicators of natural background loads. The extent of mining caused loads of metals versus natural background loads will depend on which inflows are impacted by mining activities and, where inflows are impacted by mining, the difference between any natural background loading levels versus the elevated levels caused by mining impacts.

The *Draft McLaren Pit Response Action Engineering Evaluation/Cost Analysis (EE/CA), New World Mining District Response and Restoration Project Report* (Maxim, 2001c) also discusses potential contributions from natural background conditions and relative loading inputs from a significant portion of the McLaren Pit area. The report provides reference to investigations associated with natural background conditions (Runnells, 1992; Furniss and Hinman 1998; Lovering, 1929). The studies generally suggest the existence of probable sources of elevated metals (and subsequent pH lowering conditions) associated with naturally occurring acid rock drainage due to ground water contact with naturally elevated metal-bearing bedrock materials. The transport of metals from elevated metal-bearing soils, via direct dissolution or erosion to Daisy Creek and subsequent dissolution, is also identified as a possible source. As identified in the EE/CA, absolute quantification of the amount of loading attributable to pre-mining (natural background) sources is a difficult task.

There has not been a study focused on metal quantification at higher flow events like the one discussed above. Lower levels of many metals in Daisy Creek and the Stillwater River indicate possible similar sources during high flow with some dilution from the higher flows. Additional high flow pathways include metal loading from accelerated erosion associated with roads and land disturbances, or loading from contaminated streambed sediments transported to downstream locations. Some sample locations such as SW7 show an increase in metal concentrations with increased flow, further indicating the importance of some of the above referenced high flow pathways.

There are some limited mine diggings and other limited indicators of prospecting efforts in the Stillwater drainage above the Daisy Creek confluence. Based on the 2001 MDEQ staff inspection of the area, the diggings did not appear to represent any significant threat to water quality based on the type of and area of disturbance. Sampling of the Stillwater River upstream of Daisy Creek results in metal loads that are well below those coming from Daisy Creek based on concentration and flow data (reference Maxim website and Nimick and Cleasby (2001)). Most concentrations either fall below detection limits for all metals of concern or are detected at levels well below numeric standards found within WQB-7. Based on these results, metals sources in this headwaters portion of the Stillwater River do not represent significant sources of concern at this time.

2.2.3 Sediment Source Assessment

Sediment sources include land disturbances from past mining activities (Figure 2-2), a road network (Figure 2-3) and natural background generally from undisturbed soil surfaces. Sediment transport was modeled by the USFS for the Daisy Creek drainage using the R1R4 Sediment Model (unpublished information from Mark Story, USFS). It should be noted that the R1R4 model is a fairly simplistic analysis of very complex geomorphic processes and is based on annual average precipitation. The model attempts to predict sediment levels, but actual levels in any one year can vary by a magnitude or more depending on precipitation. The model results, summarized in Table 2-4, show an annual modeled baseline, or natural background, loading rate of 22.7 tons per year. The modeled loading rate for roads in the area was 5.6 tons per year, and the loading rate for disturbed lands from previous mining activities was 5.7 tons per year. An additional sediment source includes a badly eroded section of a trail (identified in Figure 2-3).

The total modeled load from human activities of 11.3 tons per year is calculated by adding the load from roads to the load from mine disturbances. This represents 33% of the total load, or 50% above natural background.

The R1R4 modeling was not extended to the Stillwater River, although the sediment loading levels from roads and mining disturbances within the Daisy Creek drainage still

Table 2-3. Sources of Dissolved Copper to Subreaches of Daisy Creek, August 26, 1999 (from Nimick & Cleasby 2001, with addition of % total load numbers)

[Values listed for loads have been rounded. Abbreviations: μg/s, micrograms per second. Symbol: <, less than]

	Subreach extent (ft)		Dissolved copper load (μg/s)				
Subreach description[1]	Upstream site	Downstream site	Right-bank inflows	Left-bank inflows	Subsurface inflow[2]	Combined surface plus subsurface	% of total load
Moraine or landslide hill	0	270	461	<1	151	612	1.2%
Manganese bog	270	460	9,830	4	251	10,100	20.4%
Southern part of McLaren Mine Area	460	611	16,400	4	8,900	25,300	51.1%
Northern part of McLaren Mine Area	611	1,700	245	<1	7,040	7,290	14.7%
Area north and west of McLaren Mine	1,700	5,475	2	<1	6,210	6,210	12.5%
TOTAL			26,900	8	22,600	49,500	100%

[1] Describes area from which metal-rich surface drainage to subreach is derived.

[2] Calculated as the difference between the gain in instream load between upstream and downstream sites and the sum of the loads in the right-bank and left bank inflows within the subreach.

represent significant sediment sources of concern for the section of the Stillwater River addressed within this plan. This is especially true since the Stillwater River represents a depositional area for transported sediments from Daisy Creek due to a reduction in valley slope near the mouth of Daisy Creek and along the Stillwater River in the vicinity of the Daisy Creek confluence. Additional sediment loading to the Stillwater River appears to be limited to additional natural background loads outside the Daisy Creek drainage and loads associated with one access road, which happens to be in poor condition and crosses the bed of the main Stillwater River channel below the Daisy Creek confluence.

Table 2-4. Sediment Model Loading Rate Summaries for Daisy Creek

Source	Load (tons/yr)	% Total Load	Annual % > Natural
Natural Background	22.7	67	NA
Roads	5.6	16	25
Mine Disturbances	5.7	17	25

2.3 Restoration Targets, TMDLs and Load Allocations

Restoration goals and the allocation approach for Daisy Creek and the Stillwater River are first developed for metals and pH under Section 2.3.1, followed by sediment under Section 2.3.2.

2.3.1 Metals and pH Restoration Targets, TMDLs, and Allocations

2.3.1.1 Metals and pH Targets

Table 2-5 provides target values for metals and pH based on the applicable standards identified in Tables 2-1 and 2-2. Most metals targets are based on the applicable numeric water quality standard with hardness modifications for copper, cadmium, zinc, and lead. Because it is unknown what the actual hardness value will be under restoration conditions, the Table 2-5 values for copper, cadmium, zinc, and lead represent estimated values at high and low flow conditions as identified in Tables 2-1 and 2-2. The actual targets for these four metals are the water quality standard with applicable hardness adjustments based on actual in-stream hardness values at the time of measurement. Appendix A of this document provides an example of the hardness adjustment equation for chronic aquatic life support standards (reference Montana Water Quality Standards WQB-7 for more information and for the similar equation used for acute aquatic life computations).

All metal targets are based on total recoverable concentrations unless otherwise noted. For aluminum, iron, and manganese, the standard and any applicable targets are not a function of hardness. Where there are multiple numeric standards for protecting different beneficial uses, the lowest value is used to ensure protection of all beneficial uses. If the chronic and acute aquatic life targets are different than each other, then the primary target for TMDL development and restoration planning becomes the chronic aquatic life support standard to provide some margin of safety since the chronic standard is normally based on a 96-hour average.

The numeric targets cannot be exceeded at any time. At a minimum, monitoring locations DC5 and DC2 in Daisy Creek and SW7 and STW2 in the Stillwater River will be used for determining compliance with targets. The exception is for iron and aluminum concerns associated with streambed deposits and turbidity in the Stillwater River where the targets should be evaluated just below the Daisy Creek confluence. To meet the numeric targets, there must be at least three consecutive years where target values are met during late winter/early spring low flow, late summer/early fall low flow, and peak or near peak late spring/early summer runoff. All other targets further discussed below need only be measured and confirmed once in conjunction with meeting numeric levels.

Iron has an additional target of no visible streambed deposits of fine material resulting from human caused conditions. There is an additional target associated with aluminum whereby there can be no visible turbidity in the stream due to aluminum precipitates. Both of these targets apply at low flow conditions when the problems have been noted, and apply in both Daisy Creek and in the Stillwater River below the confluence of Daisy Creek.

Copper has an additional target based on stream sediment toxicity in Daisy Creek and the Stillwater River, and lead has an additional target based on stream sediment toxicity in Daisy Creek. Sediment toxicity must be measured during low flow late autumn or early spring conditions to capture impacts from runoff and associated metals depositions.

As an additional measure of overall beneficial use attainment, a target is set for macroinvertebrate and periphyton communities being at 75% or greater in comparison to reference stream conditions based on established protocols for evaluating metals and pH impairment conditions.

For pH, a range of 6.0 to 9.0 is used. This is based on the assumption that being able to meet numeric standards for metals would include a reduction in acid drainage to the point where pH would fall within this range of typical water quality conditions. Satisfying metal and pH targets is expected to help correct conditions associated with objectionable streambed deposits and turbidity associated with precipitation of metals and is also expected to help correct turbidity concerns.

2.3.1.2 Metals and pH TMDLs

Table 2-6 and 2-7 provide example TMDLs for metals and pH based on mean values from low and high flow periods which best represent water quality extremes for Daisy Creek (sample location DC5) and the Stillwater River (sample location SW7). These TMDLs are calculated as examples of typical lower and higher flow conditions, since the actual TMDL will always be dependent on specific flow conditions as defined by the following equation (also reference Appendix A of this document):

Total Maximum Load in lb/day
(X ug/l) (Y ft^3/sec) (0.00534) = (X)(Y)(0.00534) lb/day

where:
X = the applicable water quality numeric standard (target) in ug/l with hardness adjustments
where applicable (see above discussion on targets);
Y = streamflow in cubic feet per second;
(0.00534) = conversion factor

The above equation addresses all seasonal flow variations, and the examples in Tables 2-6 and 2-7 further evaluate seasonality by addressing differences associated with low and high flow conditions of hardness and pollutant levels

Some additional notes concerning the TMDLs in Tables 2.6 and 2.7 are discussed below:

The TMDL for aluminum is based on a total recoverable concentration that is thought to represent a condition where there is no longer excess aluminum available for precipitation and resulting turbidity problems. It is only applied during low flow conditions when the turbidity concerns due to aluminum precipitation have been noted. Satisfying this concentration and TMDL in Daisy Creek at DC5 is expected to result in meeting reduced turbidity goals from aluminum precipitants within both Daisy Creek and the Stillwater River. If turbidity can be avoided at total recoverable aluminum concentrations higher than the 200 ug/l, then that is acceptable since meeting the target is the ultimate goal. This TMDL will, therefore, follow a phased (adaptive management) approach since it is possible to meet the target at higher levels of aluminum.

For iron, the TMDL based on the 300 ug/l drinking water/domestic use support condition is expected to satisfy the additional target of no visible streambed deposits associated with fine materials from human causes.

Iron values are also used as a surrogate for the pH TMDL for Daisy Creek. Acid drainage, which leads to low pH values and elevated metal concentrations in ground and surface waters, results from oxidation and leaching of metals from sulfide-bearing rocks when exposed to air and water. Because of the linkage between metals loading and acidic drainage, it is assumed that restoration activities undertaken to address high metal loads from mining impacts will also address conditions leading to low pH values from these same mining impacts. Since pyrite (FeS_2) is the most commonly occurring mineral that can produce acidic drainage, then the TMDL for iron is also used as a surrogate TMDL for pH in Daisy Creek. Therefore, a mean low flow iron TMDL of 0.80 lb/day, and mean high flow iron TMDL of 45 lb/day represent loading conditions whereby pH values are expected to comply with Montana Water Quality Standards, and therefore represents the surrogate TMDL to be used for pH. This approach is further supported by results from Nimick and Cleasby (2001) where the pH reductions closely parallel increases in iron in Daisy Creek. For example, pH drops from 7.03 to 5.36 in a stretch where total recoverable iron concentrations increase from 114 ug/l to 7,070 ug/l.

Meeting the copper TMDLs associated with the numeric water quality targets is expected to satisfy the sediment toxicity targets for copper in Daisy Creek and the Stillwater River. Likewise, meeting the similar lead TMDLs in Daisy Creek is expected to satisfy the sediment toxicity target for lead in this water body as well as addressing any possible problems in the Stillwater River. As metal loading is reduced to TMDL levels, the existing fine sediments with metals contamination will likely flush through the system at high flows as they have probably been doing over the years, the difference being that they will start being replaced by fewer and cleaner fine sediment deposits.

Meeting all of the metals and pH TMDLs is expected to result in meeting the target associated with macroinvertebrate and periphyton communities being at 75% or greater in comparison to a reference stream.

Tables 2-6 and 2-7 also provide estimates of the percent total load reduction needed to meet the daily load associated with the Table 2-5 targets. These calculations are based on existing concentrations and target concentrations. The data used for these calculations were obtained from the database on the Maxim website using sampling events where metals concentrations and corresponding stream flow data were available. Typically only one representative high flow and one representative low flow set of data per year, where available, were used. Tables D-1 and D-2 in Appendix D provide a summary of the data used for Tables 2-6 and 2-7.

For Daisy Creek, note that copper requires the greatest percent reduction in total load at greater than 99% for the low flow condition and approximately 99% for the higher flow condition. Iron, manganese, cadmium aluminum and zinc also require very high percent load reductions of greater than 50% under low and/or high flow conditions. Even higher load reductions will be necessary for many metals upstream at monitoring location DC2.

For the Stillwater River, copper still requires the greatest percent reduction in total load at 74% for the low flow condition and 94% for the high flow condition. Iron is the only other metal with load reductions at greater than 50% applicable only at high flow conditions. As previously discussed, some of the high flow problems may be due to loading at low flow conditions and the subsequent re-suspension of precipitates from the streambed during these higher flows. Even higher load reductions will be needed at upstream monitoring location STW2, although meeting the load reductions at DC5 in Daisy Creek will satisfy all metal load reduction needs at locations STW2 and SW7 in the Stillwater River.

It is important to note that a given decrease in metal loading at an upstream location does not always directly result in the same loading decrease downstream, particularly during lower flows since chemical reactions associated with changing pH and related metal solubility can determine downstream concentrations. Nevertheless, any load reductions at low flow can significantly contribute to overall yearly loading reductions since there would be a significant reduction in the total amount of precipitated metals that could be re-suspended and transported downstream at higher flows.

Table 2-5. Metals and pH Water Quality Restoration Targets for Daisy Creek and the Stillwater River

Stream(s)	**Pollutant**	**Target(s)**	**Limiting Beneficial Use**
Daisy Creek & Stillwater River	Copper[1]	5.2 ug/l (high flow) 7.3 ug/l (low flow) sediment concentrations at non-toxic levels	Aquatic Life (chronic) Aquatic Life (chronic) Aquatic Life
Daisy Creek	Cadmium[1]	0.16 ug/l (high flow) 0.22 ug/l (low flow)	Aquatic Life (chronic) Aquatic Life (chronic)
Daisy Creek	Lead[1]	1.3 ug/l (high flow) 2.2 ug/l (low flow) sediment concentrations at non-toxic levels	Aquatic Life (chronic) Aquatic Life (chronic) Aquatic Life
Daisy Creek	Zinc[1]	67 ug/l (high flow) 94 ug/l (low flow)	Aquatic Life (acute & chronic) Aquatic Life (acute & chronic)
Daisy Creek & Stillwater River	Iron	300 ug/l (all flows) no visible streambed deposits (both streams) associated with controllable human causes	Drinking Water (domestic use) Aquatic Life/Aesthetics
Daisy Creek & Stillwater River	Manganese	50 ug/l	Drinking Water (domestic use)
Daisy Creek & Stillwater River	Aluminum	no precipitants causing visible turbidity at low flow conditions	Aquatic Life/Aesthetics
Daisy Creek	pH	6.0 to 9.0	Aquatic Life
Daisy Creek & Stillwater River	Metals & pH	Macroinvertebrate and periphyton communities at 75% or greater of reference stream conditions	Aquatic Life

Notes:
1. All targets for this pollutant are estimated based on predicted hardness values after completion of restoration activities, actual values will be determined by hardness as defined in Appendix A

Table 2-6. Daisy Creek TMDL and Load Reduction Examples for Metals and pH at Typical High and Low Flow Conditions

Pollutant	Target (ug/l)	Mean Low Flow (0.5 cfs) TMDL (lb/day)	Mean High Flow (28 cfs) TMDL (lb/day)	% Total Load Reduction Needed to Meet TMDLs and Targets
Copper	7.3 (low flow) 5.2 (high flow)	0.02	0.78	>99% (low flow); 99% (high flow)
Cadmium	0.22 (low flow) 0.16 (high flow)	0.0006	0.024	91% (low flow); 63% (high flow)
Lead	2.2 (low flow) 1.3 (high flow)	0.006	0.19	-- % (low flow)[1]; 43% (high flow)
Zinc	94 (low flow) 67 (high flow)	0.25	10.0	74% (low flow); 0% (high flow)[2]
Iron	Prevent objectionable streambed deposits (low flow) 300 ug/l (all flows)	0.80	45	94% (low flow); 89% (high flow)
Manganese	50	0.13	7.5	95% (low flow); 67% (high flow)
Aluminum	no precipitants causing visible turbidity (low flow conditions)	0.53 (based on 200 ug/l concentration goal)	NA	97% (low flow);
pH	6.0 to 9.0	0.80 lb/day iron load (surrogate TMDL)	45 lb/day iron load (surrogate TMDL)	94% (iron, low flow); 89% (iron, high flow)

Notes:
1. Lead values occasionally exceeded the target during low flow, but the mean low flow value is below the target
2. Zinc problems are primarily associated with low flow conditions

Table 2-7. Stillwater River TMDL and Load Reduction Examples for Metals at Typical High and Low Flow Conditions

Metal/Pollutant	Target (ug/l)	Mean Low Flow (3.5 cfs) TMDL (lb/day)	Mean High Flow (154 cfs) TMDL (lb/day)	% Total Load Reduction Needed to Meet TMDLs and Targets
Copper	7.3 (low flow) 5.2 (high flow)	0.14	4.3	74% (low flow); 94% (high flow)
Iron	300	5.6	247	0% (low flow)[1]; 66% (high flow)
Manganese	50	0.93	41	-- % (low and high flow)[2]

Notes:
1. Iron is generally not a concern at low flow conditions at SW7
2. Manganese occasionally exceeds or equals the target at low and high flow conditions, but the mean low flow values are below the target

2.3.1.3 Performance Based Load Allocation Approach for Metals and pH

A performance based allocation approach is used for metals and pH load allocations. This approach relies on detailed plans and practices that will be developed and applied to all significant mining sources impacting Daisy Creek and the Stillwater River. The *Petition Report* (Stanley, 1999) and the *Final Overall Project Work Plan for the New World Mining District Response and Restoration Project* (Maxim, 1999) provide details concerning the overall restoration strategy for District and some non-District property within the Cooke City Planning Area. The *Petition Report* specifically includes schedules and detailed site descriptions and anticipated restoration activities. The *Final Work Plan* further describes the process whereby potential pollutant sources (e.g. mine dumps, adits, etc.) are evaluated and restoration approaches are analyzed in detail and undergo stakeholder review and comment prior to selection of a final restoration approach for each location of concern. The information is then documented in an annual work plan, which may address one or more locations where restoration is planned over the coming year. This process continues every year with the goal of achieving cleanup by 2014 as required by the Temporary Water Quality Standards. *The New World Mining District Response and Restoration Project: Project Summary, 2001*(Maxim, 2001b) also describes the restoration planning and implementation process for the District.

Overall, a total of 18 source areas have been identified in the District. The source areas that involve Daisy Creek and the Stillwater River, including a summary of the general activities that are planned as well as some potential restoration actions, are discussed below (reference Figures 2-2 and 2-3).

•District Property	Includes all property or interest relinquished by CBMI. Activities will include: surveying the District for additional sources; characterize chemistry, thickness, and quantity of sources (waste rock dumps or tailings) through borehole drilling; identify and investigate potential waste rock disposal sites; identify potential borrow sources; survey cultural resources; and monitor surface and ground water resources. Restoration activities can include activities such as removal to the repository site and/or drainage control.
•McLaren Pit	Complete the hydrologic evaluation and determine necessary controls for reducing pit inflows; determine pit holding capacity; characterize waste rock dumps; evaluate source control and water treatment options; install and maintain stormwater sediment control; monitor and maintain revegetated areas; establish whether all underground mine workings are identified; insure that all capped boreholes are secure; and monitor water diversion system, erosion control practices, and water quality. The *Draft McLaren Pit EE/CA* (Maxim, 2001c) should be referenced for a discussion of restoration options which consider capping, lime additions, and revegetation. The 2002 Annual Work Plan (yet to be

developed) will then provide details on selected restoration efforts for the coming field season.

- Road Systems — Roads within or accessing District Property will be evaluated to determine which roads should be closed and which roads will be used during removal actions. In addition, best management practices typically associated with drainage improvements and other erosion controls will likely be pursued on roads and trails where closure is not consistent with overall forest recreational goals.

- Wetland, Stream Bank — Includes contaminated material deposited along stream thalwegs and transported sources and bog material with elevated metal concentrations. Disturbances in this source area will be characterized to determine necessary removal actions.

Figure 2-2 shows the locations of most or all of the mine disturbances in the Daisy Creek and Stillwater River drainages. These mine disturbances can all be addressed under one or more of the above categories. For example, the Daisy Pass Dumps are not specifically identified above, but do fall under the overall category of District Property, and will therefore be addresses as discussed above. Figure 2-3 shows the road network that is discussed above under the Road Systems category. Erosion control efforts focused on the mine disturbances identified in Figure 2-2, as well as some of the roads and trails in the vicinity of the mine disturbances, will further reduce metal loading to both streams.

Some of the potential sources of metals to Daisy Creek and the Stillwater River include erosion from roads and other disturbed areas and sources located on non-District Property. The *Consent Decree and Settlement Agreement* (United States District Court for the District of Montana Billings Division, 1998) provides further restoration guidance for all sources in the Daisy, Fisher, and Miller Creek drainages as well as sources within the whole New World Mining District. Per the Natural Resources Working Group for the New World Mining District Response and Restoration Project, there are two categories of work that can be done (Natural Resources Working Group Meeting Summary, June 19, 2002). These are:

- Category A - hazardous substances (i.e. mine waste) that are on District Property and non-hazardous substances (e.g. principally sediment from roads) on District Property. Work can be done prior to the receipt of the Notice of Completion from the United States Government.

- Category B – after receipt of the Notice of Completion, work can address other hazardous and non-hazardous sources on non-District Property.

It is assumed that all significant metals and pH related sources, other than natural background sources, to Daisy Creek and the Stillwater River are "Category A" type sources and will be addressed as part of the consent decree requirements for a notice of completion. These sources are identified on Figure 2-2 or are yet to be identified as part of the New World Mining District restoration efforts. It is also assumed that for all these sources, restoration activities will be implemented in a manner that represents all reasonable land, soil, and water conservation practices and therefore will satisfy the intent of Montana's Water Quality Standards. This includes appropriate implementation monitoring and maintenance of restoration efforts to ensure success.

If a source of metals located on non-District Property does happen to be identified as significant then it will be addressed under “Category B” within the budget constraints after issuance of the notice of completion. If there is not adequate budget within the New World restoration project, then a load will be allocated to this source to reflect loading conditions needed to ensure that water quality targets would be met once the new allocation is satisfied. This is not expected to happen given the previous discussions on significant source locations and their relations to District Property and non-District Property within the Daisy Creek and Stillwater River drainages.

As previously discussed, once metals loading approaches TMDL levels the existing fine sediments with metals contamination will likely flush through the system at high flows as they have probably been doing over the years, the difference being that they will start being replaced by fewer and cleaner fine sediment deposits. Note that the restoration work for the “Wetland, Stream Bank” source area is intended to verify this assumption and address significantly high levels of metals contaminants in stream sediments and floodplain material if they did not flush through the system as anticipated.

Section 5.0 in this document summarizes some additional components of the overall restoration strategy for Daisy Creek and the Stillwater River.

2.3.2 Sediment Restoration Targets, TMDL Goals and Allocations

2.3.2.1 Sediment Targets

For sediment, target development is based on criteria currently found within *Appendix A of Water Quality Assessment Process and Methods* (MDEQ, 2000). The Appendix A document provides guidelines for making beneficial use support determinations, and essentially provides a process for interpreting narrative water quality standards, such as those that exist for sediment, under certain conditions of data availability.

There are two water quality restoration targets for sediment in Daisy Creek and the Stillwater River, both of which are presented below:

- Periphyton and macroinvertebrate biota at 75% of reference condition based on established protocols for evaluating sediment impairment conditions

AND

- The habitat conditions must represent 75% of the reference condition by allowing no greater than a 25% average increase above reference condition percent fines data for all sizes less than D_{50}.

The first target is based on biological data since ideally this would best represent aquatic life beneficial use support. The second target is developed as a method to directly measure sediment impacts on habitat conditions relative to a reference stream. Meeting this habitat condition is assumed to support biota at a 75% level of reference conditions from a sediment impact perspective. The sizes less than D_{50} are chosen to ensure that particle sizes generally associated with aquatic life impacts, such as 6.35 mm and smaller, are the primary focus.

The Stillwater River just upstream of Daisy Creek serves as the reference stream for both Daisy Creek and the Stillwater River below Daisy Creek. Figure 2-4 is the same as the Figure 2-1 percent fines curves with an additional target line curve added to represent the 25% increase in percent fines. Meeting the habitat target would involve measurements, on the average, falling below the target curve for each impaired water body. Note that current percent fines conditions for Daisy Creek and the Stillwater River below Daisy Creek are currently well above the 25% target line at the low end of the scale (i.e. values less than the D_{50}).

Because percent fines curves can vary from time to time at the same locations, future comparisons to reference conditions curves must be made using measurements from the same day for each water body, including the reference stream. Measurements to evaluate status toward meeting the sediment target should be taken during the lower flow summer or fall season after spring runoff conditions. A similar approach in comparing biota between Daisy Creek and the Stillwater River to reference stream conditions also applies.

It is recognized that the uppermost portion of the Stillwater River represents a fairly pristine reference stream condition. In addition, possible confounding effects of potentially long term elevated metal concentrations in the water column and in sediments of Daisy Creek and the Stillwater River below Daisy Creek may make it difficult to meet the biota target as currently defined. For this reason, the sediment targets will be evaluated at least every five years for suitability and may be modified based on identification of a more suitable reference stream and/or identification of a better indicator of habitat conditions needed to support aquatic life. The sediment targets could also be modified to represent anticipated conditions associated with the implementation of sediment control and mine restoration activities in both the Daisy Creek and Stillwater drainage areas in a manner that represents the application of all reasonable land, soil and water conservation measures.

2.3.2.2 Sediment TMDLs and Load Allocations

As previously discussed under Source Characterization (Section 2.2.3), the current modeled annual percent sediment yield above natural background for Daisy Creek has been calculated at 50%, which amounts to 11.3 tons of sediment above and beyond the natural background of load of 22.7 tons. Based on expected erosion control efforts associated with the McLaren Pit and other mine disturbances, in addition to road improvements, it is envisioned that the modeled annual percent greater than natural background loading to Daisy Creek will be reduced from 50% to 38% or less (discussions with Mark Story, USFS). This would mean that the modeled 11.3 tons of sediment from roads and mining activities would be reduced to 8.6 (38/50 x 11.3) tons or less. This 8.6 tons per year load represents a yearly load allocation to Daisy Creek and the Stillwater

River for the major controllable sources. This sediment load of 8.6 tons per year above natural background plus the natural background load of 22.7 tons equals 31.3 tons per year. This modeled 31.3 tons per year represents a total maximum yearly load for the major sediment sources of concern and represents the surrogate TMDL for both Daisy Creek and the Stillwater River below Daisy Creek, since the Daisy Creek drainage is by far the primary source of problem causing sediments to the Stillwater River.

Table 2-8 provides a summary of the sediment load allocations and percent reductions by source category for both water bodies. It is assumed that the sediment loads and all identified load reductions in Table 2.8 will result in conditions that meet the sediment targets for both water bodies. Note that the actual yearly load for the Stillwater River will include additional natural background loads and insignificant human related loads from outside the Daisy Creek drainage. The possible exception to insignificant human related loads is the road to Lake Abundance. An additional 50% reduction in load from the sections of the road to Lake Abundance that are located outside of the Daisy Creek drainage but still within the Stillwater River drainage is also part of the load allocation and modification to the TMDL for the Stillwater River. The load reduction can be based on modeling or can be achieved via successful implementation and maintenance of erosion control best management practices as verified by MDEQ and Forest Service water quality personnel. This same load reduction approach is also applied to a badly eroding trail within the Daisy Creek drainage and therefore represents a modification to the TMDL and load allocations to Daisy Creek and the Stillwater River.

It is important to note that the actual annual sediment variation can be an order of magnitude greater due to climatic variability, whereas the primary load allocation and TMDL are based on modeled sediment yields assuming average annual precipitation.

Because there is uncertainty associated with the assumption that the Table 2-8 load allocations will result in meeting sediment targets for both water bodies, an adaptive management or phased approach will be pursued. As restoration efforts continue and reductions in sediment yield are achieved, measurements will be taken to evaluate progress toward meeting targets. If it looks like greater reductions in sediment loading are needed, then a new TMDL and new load allocations will be developed in recognition of the need to further reduce sediment yield in the Daisy Creek and Stillwater River drainages. Any modifications to the sediment targets, as discussed above under Section 2.3.2.1, will also be incorporated into this adaptive management approach

Table 2-8. Modeled Sediment Load Allocations for Daisy Creek and the Stillwater River

Source Category	Existing Load (tons/yr)	Load Allocation (tons/yr)	% Reduction in Load by Source Category
Natural Background in Daisy Creek Drainage	22.7	22.7	0%
Natural Background in Stillwater River drainage (not including Daisy Creek drainage)	Not modeled (does not need to be for this allocation)	Set to existing levels	0%
Roads in Daisy Creek Drainage	5.6	4.0	28%
Mine Disturbances in Daisy Creek Drainage	5.7	4.6	20%
Trail Erosion in Daisy Creek Drainage	Not modeled (does not need to be if trail meets applicable erosion control practices)	50% of existing load accomplished by meeting erosion control best management practices	50%
Lake Abundance Road Section not in Daisy Creek Drainage	Not modeled (does not need to be if road meets all erosion control practices)	50% of existing load accomplished by meeting erosion control best management practices	50%
Other trails, mines, and human disturbances in the Stillwater River drainage only	Not modeled (does not need to be since no load reductions will be pursued)	Set to existing minimal levels representing probable naturally occurring conditions	0%

SECTION 3.0 FISHER CREEK AND THE CLARKS FORK OF THE YELLOWSTONE RIVER WATER QUALITY RESTORATION

3.1 Impairment Conditions

Fisher Creek and the Clarks Fork of the Yellowstone River (Clarks Fork) are both impacted from elevated metals concentrations and low pH values. Sediment deposits also impact Fisher Creek. Many reports and data sources identify impacts to beneficial uses. Section 3.1.1 below provides impairment details associated with metals and pH, and Section 3.1.2 provides impairment details associated with sediment.

3.1.1 Metals and pH

The *Petition Report* for temporary standards includes water quality data tables for Fisher Creek and the Clarks Fork. Included in the data tables are statistical summaries of the analytical data from 1989 through 1998. Another report, entitled *Quantification of Metal Loading in Fisher Creek by Tracer Injection and Synoptic Sampling, Park County, Montana, August 1997* (Kimball et al., 1999) provides sample results at numerous locations along Fisher Creek during a relatively low flow time of the year. In addition, the Maxim website (Maxim, 2001a) provides significant water quality and sediment metals concentration data. Additional sediment metals concentration data are also available based on work done to support restoration efforts (Camp, Dresser and McKee, 1997).

The above referenced information and other reports show that conditions in Fisher Creek do not fully support the beneficial uses associated with a B-1 classification and do not comply with applicable B-1 standards for copper, iron, manganese, aluminum, zinc, cadmium, lead, silver, and pH. This causes significant negative impacts to aquatic life from the elevated metals concentrations and low pH values (reference Section 1.2.4). In addition to metal concentration and pH concerns, metal precipitates associated with iron and aluminum settle to form objectionable sludge deposits in Fisher Creek and can also cause increased turbidity. These deposits and the associated turbidity from metal precipitates negatively impact the aesthetics of Fisher Creek and add further to the negative impacts to aquatic life.

The above referenced information and other reports show that conditions in the Clarks Fork below Fisher Creek do not fully support the beneficial uses associated with a B-1 classification and do not comply with applicable B-1 standards for copper, zinc, cadmium, lead, silver and pH. Section 1.2.4 provides discussion associated with these negative impacts to aquatic life from pollutants in Fisher Creek.

Tables 3-1, 3-2, and 3-3 provide summaries of the impairment concerns associated with metals and pH. All metal concentrations are total recoverable unless otherwise noted. The metals concentrations and pH values are from Fisher Creek sampling locations SW3 and SW4, and Clarks Fork sampling location SW6. The Fisher Creek sample locations SW3 and SW4 capture most or all mining impacts and provide representation of the significant mining impacts to water quality. Location SW3 represents the more severe upstream mining impacts and SW4 represents most or all impacts at a further downstream location where these impacts are less severe. The Clarks Fork sample location SW6 represents water quality impacts from Fisher Creek to the Clarks Fork upstream of any major tributaries to the Clarks Fork. All three sampling locations, which are shown in Figure 1-3, are routinely used to track water quality in this stream and to measure progress of ongoing restoration efforts. As expected, metal concentrations in the Clarks Fork are significantly lower than in Fisher Creek since Fisher Creek flows into the Clarks Fork and essentially all significant contaminant sources are in the Fisher Creek drainage. In fact, values are low enough for some metals such that the concentrations are below water quality standards, meaning that a TMDL is not necessary for that particular metal in the Clarks Fork.

Appendix B provides a descriptive water quality summary for each of the metals of concern and pH as they relate to impairment determinations.

3.1.2 Impairment Conditions Associated with Sediment

Eroded soils and metal precipitates create impairment conditions due to deposition in the streambed. This discussion focuses on potential impairment conditions associated with eroded soils, although it is recognized that these eroded soils also transport metal contaminants. It is also further recognized that precipitation of metals to the streambed can confound efforts to measure sediment impacts and that these precipitates can negatively impact aquatic life in a manner similar to sediment impacts.

The New World Project Draft EIS provides percent fines sample results from monitoring locations at or near SW4. These results show that the mean percent of particles 6.3 mm or smaller in diameter was 19.6 percent and the range was 11.7 to 39.4 percent. The mean percent particle size 2.38 mm diameter and smaller was 18%, indicating that most particles smaller than 6.3 mm are also smaller than 2.38 mm. Embeddedness measurements in Fisher Creek were also relatively high based on measurements from 1990 through 1993, generally in the 25 to 50% range.

In addition to the above measured data, the USFS has modeled the sediment yield above natural sediment levels for Fisher Creek (Draft EIS, 1996) using the R1R4 model. The modeled results show that on an annual basis, the modeled sediment yield is 36% above natural sediment levels for Fisher Creek, which can lead to conditions that do not fully support aquatic life in a stream with a B-1 classification. A subsequent field visit by MDEQ water quality specialists during August 2001 further verified the probability of impairment based on observation of high apparent embeddedness and percent fines conditions in a lower gradient meandering section of Fisher Creek where some of the more suitable fish habitat exists.

Table 3-1. Fisher Creek Metals and pH Impairment Summary (Sample Site SW3)

Pollutant	Sampling Results	Water Quality Standard Concern	Water Quality Standards Reference(s)
Copper	30 - 1530 ug/l	- consistently > 2.8 ug/l chronic aquatic life (high flow)[1] - consistently > 4.2 ug/l chronic aquatic life (low flow)[1] - consistently > 3.8 ug/l acute aquatic life (high flow)[1] - consistently > 5.9 ug/l acute aquatic life (low flow)[1] - elevated copper levels in sediment	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d)
Iron	40 - 11,600 ug/l	- consistently > 1000 ug/l chronic aquatic life - consistently > 300 ug/l domestic use - consistently forms objectionable streambed deposits	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(a) 17.30.637(1)(d)
Manganese	160 - 1670 ug/l	- consistently > 50 ug/l domestic use	17.30.623(2)(h)(i) - WQB-7
Aluminum	1360 - 5000 ug/l (dissolved) 1100 - 4800 ug/l (total recoverable)	- consistently > 87 ug/l aquatic life for dissolved aluminum (chronic at pH 6.5 to 9.0; but no detections of concern are within this pH range) - consistently forms objectionable streambed deposits - consistently produces high turbidity from colloidal precipitants	17.30.637(1)(d) 17.30.623(2)(d)
Zinc	30 - 290 ug/l	- consistently > 37 ug/l chronic & acute aquatic life (high flow)[1] - consistently > 55 ug/l chronic & acute aquatic life (low flow)[1]	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d)
Cadmium	< 0.1 - 2.2 ug/l	- sometimes > 0.10 chronic aquatic life (high flow)[1] - often > 0.14 ug/l chronic aquatic life (low flow)[1] - possibly never > 0.52 ug/l acute aquatic life (high flow)[1] - sometimes > 0.84 ug/l acute aquatic life (low flow)[1]	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d)
Lead	< 3 - 9 ug/l	- often > 0.54 ug/l chronic aquatic life (high flow)[1] - consistently > 0.99 ug/l chronic aquatic life (low flow)[1]	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d)
Silver[2]	< 0.5 - 1.1 (2 to 4 detections)	> 0.37 acute aquatic life (high flow)[1] > 0.84 acute aquatic life (low flow)[1]	17.30.623(2)(h)(i) - WQB-7
pH	2.9 - 6.6 (field)	- below expected naturally occurring levels - contributes to metals solubility and resulting precipitation problems	17.30.623(2)(c) 17.30.637(1)(d)

1 Standards reflect adjustments for water hardness, which varies during lower flow periods (generally before and after runoff) and higher flow periods (generally during late spring and early summer runoff) in Fisher Creek; the low flow hardness value used for Fisher Creek is 40 mg/l calcium carbonate; and the higher flow hardness value is 25 mg/l as calcium carbonate.

2 Silver does not have a chronic aquatic life standard

Table 3-2. Fisher Creek Metals and pH Impairment Summary (Sample Site SW4)

Pollutant	Sampling Results	Water Quality Standard Concern	Water Quality Standards Reference(s)
Copper	< 1 - 180 ug/l	- consistently > 2.8 ug/l chronic aquatic life (high flow)[1] - consistently > 4.2 ug/l chronic aquatic life (low flow)[1] - consistently > 3.8 ug/l acute aquatic life (high flow)[1] - consistently > 5.9 ug/l acute aquatic life (low flow)[1] - elevated copper levels in sediment	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d)
Iron	< 30 - 3,170 ug/l	- sometimes > 1000 ug/l chronic aquatic life - consistently > 300 ug/l domestic use - consistently forms objectionable streambed deposits	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(a) 17.30.637(1)(d)
Manganese	< 10 - 160 ug/l	- often > 50 ug/l domestic use	17.30.623(2)(h)(i) - WQB-7
Aluminum	< 100 - 1300 ug/l (dissolved) <100 - 1100 ug/l (total recoverable)	- consistently > 87 ug/l aquatic life for dissolved aluminum (chronic at pH 6.5 to 9.0; many detections of concern are within this pH range) - consistently forms objectionable streambed deposits - consistently produces high turbidity from colloidal precipitants	17.30.637(1)(d) 17.30.623(2)(d)
Zinc	< 10 - 80 ug/l	- sometimes > 37 ug/l chronic & acute aquatic life (high flow)[1] - often > 55 ug/l chronic & acute aquatic life (low flow)[1]	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d)
Cadmium	< 0.1 - 2 ug/l	- sometimes > 0.10 chronic aquatic life (high flow)[1] - sometimes > 0.14 ug/l chronic aquatic life (low flow)[1] - sometime > 0.52 ug/l acute aquatic life (high flow)[1] - sometimes > 0.84 ug/l acute aquatic life (low flow)[1]	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d)
Lead	< 1 - 10 ug/l (3 detections)	- sometimes > 0.54 ug/l chronic aquatic life (high flow)[1] - elevated lead levels in sediment	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d)
Silver[2]	< 0.2 - 9 (2 detections)	> 0.37 acute aquatic life (high flow)[1] > 0.84 acute aquatic life (low flow)[1]	17.30.623(2)(h)(i) - WQB-7
pH	5 - 9.1 (field)	- below naturally occurring levels during much of the year, particularly upstream of SW4 - contributes to metals solubility and resulting precipitation problems	17.30.623(2)(c) 17.30.637(1)(d)

1 Standards reflect adjustments for water hardness, which varies during lower flow periods (generally before and after runoff) and higher flow periods (generally during late spring and early summer runoff) in Fisher Creek; the low flow hardness value used for Fisher Creek is 40 mg/l calcium carbonate; and the higher flow hardness value is 25 mg/l as calcium carbonate.
2 Silver does not have a chronic aquatic life standard

Table 3-3. Clarks Fork River Below Fisher Creek Metals Impairment Summary (Sample Site SW6)

Pollutant	Sampling Results	Water Quality Standard Concern	Water Quality Standards Reference(s)
Copper	< 1 – 70 ug/l	- consistently > 2.8 ug/l chronic aquatic life (high flow)[1] - consistently > 4.2 ug/l chronic aquatic life (low flow)[1] - consistently > 3.8 ug/l acute aquatic life (high flow)[1] - consistently > 5.9 ug/l acute aquatic life (low flow)[1] - elevated copper levels in sediment	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d)
Zinc	< 10 – 40 ug/l (high flow) < 10 – 50 ug/l (low flow)	- sometimes > 37 ug/l chronic & acute aquatic life (high flow)[1] - < 55 ug/l chronic & acute aquatic life (low flow)[1]	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d)
Cadmium	3 high flow detections at 1, 2, and 80 (sample or reporting error?)	- sometimes > 0.10 chronic aquatic life (high flow)[1] - < 0.14 ug/l chronic aquatic life (low flow)[1] - sometime > 0.52 ug/l acute aquatic life (high flow)[1] - < 0.84 ug/l acute aquatic life (low flow)[1]	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d)
Lead	Consistently below detection	- elevated lead levels in sediment	
Silver[2]	< 0.2 – 30 (2 detections)	> 0.37 acute aquatic life (high flow)[1] > 0.84 acute aquatic life (low flow)[1]	17.30.623(2)(h)(i) - WQB-7
pH	4.8 – 9.4 (field)	- possibly below naturally occurring levels during parts of the year presumably due to Fisher Creek pollutant impacts	17.30.623(2)(c)

1 Standards reflect adjustments for water hardness, which varies during lower flow periods (generally before and after runoff) and higher flow periods (generally during late spring and early summer runoff) in the Clarks Fork River; the low flow hardness value used for the Clarks Fork River is 40 mg/l calcium carbonate; and the higher flow hardness value is 25 mg/l as calcium carbonate.

2 Silver does not have a chronic aquatic life standard

At this time, a suitable reference stream has not been identified and measured as was done for Daisy Creek and the Stillwater River, and a determination on impairment status relating to sediment is difficult to make with the same degree of certainty. None of the three previous 303(d) lists (1996, 1998, and 2000) identify sediment as a pollutant of concern for Fisher Creek. Nevertheless, the high levels of modeled sediment yield, increased levels of embeddedness, and especially the high level of percent fines less than 2.38 mm all provide sufficient credible data for an impairment determination. For this reason, a sediment target, TMDL, and allocations are identified for sediment in Fisher Creek. Efforts to ensure reduced sediment production can then be coordinated with ongoing restoration efforts, which address both metals and sediment loading sources as part of the New World Cleanup. In fact, at least one major source of sediment loading has already been addressed via road improvements that the Forest Service had completed along the main Fisher Creek Road.

As implied above, the additional yield in sediment from Fisher Creek may have some level of negative impact on the Clarks Fork River below Fisher Creek. At this time it is not considered sufficient enough to cause impairment conditions because of naturally occurring high levels of sediment transport including elevated levels from relatively recent fire activities. Therefore, target and TMDL development is not pursued for sediment in the Clarks Fork River, although it should be recognized that efforts to address sediment loading to Fisher Creek will also result in reduced sediment loading from many of the human related activities impacting the Clarks Fork River.

3.2 Source Characterization

3.2.1 Source Inventory

Mining disturbances primarily associated with historical adits and waste rock represent the sources of increased metals and pH conditions due to human activities in the Fisher Creek and Clarks Fork River drainage areas. Figure 3-1 shows the locations of these mining disturbances, with the Glengary Adit representing one of the most significant sources of metals and pH lowering constituents. These same mining disturbances, along with an existing and historic road network shown by Figure 3-2, represent the primary sources of increased sediment loads from human activities. This increased loading of sediment from erosion also represents a potential pathway for metal contaminants located in the soils or along eroding stream banks, although not all eroded soils will necessarily be associated with increased metal transport.

Forest, high elevation shrubland, rock and some transitional areas from recent fires cover most of the remaining drainage area (Figure 1-2). Therefore, there appears to be a low probability of any other human related sources that could represent significant loading for any of the pollutants of concern. In addition, neither of the impaired water bodies or their tributaries receive point source discharges regulated by a Montana Pollutant Discharge Elimination System permit, meaning that waste load allocations are not necessary for these water bodies.

3.2.2 Metals and pH Source Assessment

As previously discussed, higher metal concentrations in Fisher Creek generally occur during low flow periods. This is when metals loading is predominately transported via acidic ground water discharging directly to Fisher Creek or discharging to springs which run into Fisher Creek, all of which have the potential to ultimately impact the Clarks Fork River. In some of the upper headwaters tributaries pH values are relatively low. The pH values then significantly decrease in the area of the Glengary Adit discharge, and then increase in the downstream direction along Fisher Creek to the point where pH is no longer thought to be of concern within the Clarks Fork River during most of the year. This increase in pH promotes the precipitation of metals, which subsequently settle to the bed of Fisher Creek and ultimately result in reduced water column concentrations (and perhaps increased concentrations of metals in sediments) in a downstream direction during low flow conditions. Metals concentrations within the Clarks Fork River decrease even further in a downstream direction due to additional dilution from tributaries and possible additions of clean sources of ground water.

The Kimball et al. (1999) synoptic sampling study provides metals loading information for Fisher Creek. This information was developed during a relatively low flow time of year, on a subreach by subreach scale, looking at both surface inflows and subsurface inflows. In general, it was found that about 60% of the aluminum, copper, manganese, and zinc loads can be attributed to visible inflows, including the Glengary Adit, which contributes about 32% of the total copper load during low flow conditions. The remaining 40% were found to be from diffuse subsurface (ground water) inflows. As was the case for Daisy Creek and the Stillwater River, much of this low flow load settles to the streambed of Fisher Creek and is re-suspended during higher flows, thus contributing to the high flow downstream loads.

Appendix E is an excerpt from the Kimball et al. (1999) report that includes a discussion on metal sources and the overall study summary and conclusions. This information provides good loading curves in a downstream direction for most metals of concern. Note that the copper loading curve from this report shows a significant increase in copper load at the Glengary Adit location as well as from mine waste drainage. Similar loading curve shapes also exist for other metals as shown by the figures in Appendix E.

There has not been a study focused on metal quantification at higher flow events like the one discussed above. Lower concentrations at high versus low flow for many metals in Fisher Creek and the Clarks Fork River indicate possible similar sources during high flow with some dilution from the higher flows. Additional high flow pathways include metal loading from accelerated erosion associated with roads and land disturbances, or loading from contaminated streambed sediments transported to downstream locations. Some sample locations such as SW6 show an increase in some metal concentrations with increased flow, further indicating the importance of some of the above referenced high flow pathways.

Though the Kimball et al. (1999) study provides a good summary of relative inputs by location and by pollutant pathway, there is still significant uncertainty and debate as to the extent of metals and pH-related loads associated with natural background. The extent of mining caused loads of metals versus natural background loads will depend on which inflows are impacted by mining activities and, where inflows are impacted by mining, the difference between any natural background loading levels versus the elevated levels caused by mining impacts.

As discussed under the Daisy Creek and Stillwater River Source Characterization (Section 2.2.2), there have been several investigations associated with natural background conditions in the area of interest (Runnells, 1992; Furniss and Hinman 1998; Lovering, 1929). The studies generally suggest the existence of probable sources of elevated metals (and subsequent pH lowering conditions) associated with naturally occurring acid rock drainage due to ground water contact with naturally elevated metal-bearing bedrock materials. The transport of metals from elevated metal-bearing soils, via direct dissolution or erosion to Fisher Creek and subsequent dissolution, is also a possible natural source. Nevertheless, absolute quantification of the amount of loading attributable to pre-mining (natural background) sources is a difficult task.

Lady of the Lake Creek (Figure E-2) appears to contribute some minor metal loading to the Clarks Fork River at levels normally below water quality standards and therefore this tributary may not be of significant concern. The possible exception is potentially high copper loads during very high flow events based on the results from one sampling event (6/19/96; 400 cfs; 29 ug/l total recoverable copper). There appears to be a lack of significant mining related pollutant sources in the Lady of the Lake Creek drainage. This indicates a need for further investigation to determine whether or not Lady of the Lake Creek is impaired and/or represents a significant copper load to the Clarks Fork River during very high flow events, and whether or not there are controllable sources if high metals loading is verified. Similar such work is needed for the Broadwater River as discussed in Section 3.4 below.

3.2.3 Sediment

Sediment sources include land disturbances from past mining activities (Figure 3-1), an existing and historical road network (Figure 3-2), and natural background generally from undisturbed soil surfaces. Sediment transport was modeled by the USFS for the Fisher Creek drainage using the R1R4 Sediment Model (Draft EIS, 1996). It should be noted that the R1R4 model is a fairly simplistic analysis of very complex geomorphic processes and is based on annual average precipitation. The model attempts to predict sediment levels, but actual levels in any one year can vary by an order of magnitude or more depending on precipitation. The model results, summarized in Table 3-4, show an annual modeled baseline, or natural background, loading rate of 38 tons per year. Roads and disturbed lands from previous mining activities were combined in the model and resulted in 13 tons per year. This represents 25% of the total 51 ton yearly modeled load, or 34% above natural background.

Table 3-4. Sediment Model Loading Rate Summaries for Fisher Creek:

Source	Load (tons/yr)	% Total Load	Annual % > Natural
Natural Background	38	75	NA
Roads & Mine Disturbances	13	25	34

3.3 Restoration Targets, TMDLs, and Load Allocations

Restoration goals and the allocation approach for Fisher Creek and the Clarks Fork River are first developed for metals and pH under Section 3.3.1, followed by sediment under Section 3.3.2.

3.3.1 Metals and pH Restoration Targets, TMDLs and Allocations

3.3.1.1 Metals and pH Targets

Table 3-5 provides target values for metals and pH. Most metals targets are based on the applicable numeric water quality standard identified in Tables 3-1 through 3-3, with hardness modifications for copper, cadmium, zinc, lead, and silver. Because it is unknown what the actual hardness value will be under restoration conditions, the Table 3-5 values for copper, cadmium, zinc, lead, and silver represent estimated values at high and low flow conditions as defined in Tables 3-1 through 3-3. The actual targets for these five metals are the water quality standard with applicable hardness adjustments based on actual in-stream hardness values at the time of measurement. Appendix A of this document provides an example of the hardness adjustment equation for chronic aquatic life support standards (reference Montana Water Quality Standards WQB-7 for more information and for the similar equation used for acute aquatic life computations).

All metal targets are based on total recoverable concentrations unless otherwise noted. For aluminum, iron, and manganese, the standard and any applicable targets are not a function of hardness. Where there are multiple numeric standards for protecting different beneficial uses, the lowest value is used to ensure protection of all beneficial uses. If the chronic and acute aquatic life targets are different than each other, then the primary target for TMDL development and restoration planning becomes the chronic aquatic life support standard to provide some margin of safety since the chronic standard is normally based on a 96-hour average.

The numeric targets cannot be exceeded at any time. Monitoring locations SW3 (Fisher Creek), SW4 (Fisher Creek), and SW6 (Clarks Fork River) should be used for determining compliance with targets based on water quality and sediment metals concentrations, whereas iron and aluminum targets associated with precipitants and turbidity should apply at any locations below SW3. To meet the numeric targets, there must be at least three consecutive years where target values are met during late winter/early spring low flow, late summer/early fall low flow, and peak or near peak late spring/early summer runoff. All other targets further discussed below need only be measured and confirmed once in conjunction with meeting numeric levels.

> Iron has an additional target of no visible streambed deposits of fine material resulting from human caused conditions, and there is an additional target associated with aluminum whereby there can be no visible turbidity in the stream due to aluminum precipitates. Both of these targets apply at low flow conditions in Fisher Creek when the problems have been noted.

Copper and lead both have additional targets based on stream sediment toxicity that applies to both streams. Sediment toxicity must be measured during low flow late autumn or early spring conditions to capture impacts from runoff and associated metals depositions.

As an additional measure of overall beneficial use attainment, a target is set for macroinvertebrate and periphyton communities being at 75% or greater in comparison to reference stream conditions based on established protocols for evaluating metals and pH impairment conditions.

For pH, a range of 6.0 to 9.0 is used. This is based on the assumption that being able to meet numeric standards for metals would include a reduction in acid drainage to the point where pH would fall within this range. Satisfying metal and pH targets is expected to help correct conditions associated with objectionable streambed deposits and turbidity associated with precipitation of metals.

3.3.1.2 Metals and pH TMDLs

Tables 3-6, 3-7, and 3-8 provide TMDL values for metals and pH based on mean values from low and high flow periods which best represent water quality extremes for Fisher Creek (sample locations SW3 and SW4) and the Clarks Fork River (sample location SW6). These TMDLs are calculated as examples of typical lower and higher flow conditions, since the actual TMDL will always be dependent on specific flow conditions as defined by the following equation (also reference Appendix A of this document):

<u>Total Maximum Load in lb/day</u>
(X ug/l) (Y ft^3/sec) (0.00534) = (X)(Y)(0.00534) lb/day

where:
X = the applicable water quality numeric standard (target) in ug/l with hardness adjustments
where applicable (see above discussion on targets);
Y = streamflow in cubic feet per second;
(0.00534) = conversion factor

The above equation addresses all seasonal flow variations, and the examples in Tables 3-6 through 3-8 further evaluate seasonality by addressing differences associated with low and high flow conditions of hardness and pollutant levels.

Some additional notes concerning the TMDLs in Tables 3.6 through 3.8 are discussed below:

The TMDL for aluminum is based on a total recoverable concentration of 200 ug/l that is thought to represent a condition where there is no longer excess aluminum available for precipitation and resulting turbidity problems. It is only applied during low flow conditions when the turbidity concerns due to aluminum precipitation have been noted. If turbidity can be avoided at total recoverable aluminum concentrations higher than the 200 ug/l, then that is acceptable since meeting the target is the ultimate goal. This

TMDL will, therefore, follow a phased (adaptive management) approach since it is possible to meet the target at higher levels of aluminum.

For iron, the TMDL in Fisher Creek based on the 300 ug/l drinking water/domestic use support condition is expected to satisfy the additional target of no visible streambed deposits associated with fine materials from human causes.

Iron values are used as a surrogate for the pH TMDL for Fisher Creek. Acid drainage, which leads to low pH values and elevated metal concentrations in ground and surface waters, results from oxidation and leaching of metals from sulfide-bearing rocks when exposed to air and water. Because of the linkage between metals loading and acidic drainage, it is assumed that restoration activities undertaken to address high metal loads from mining impacts will also address conditions leading to low pH values from these same mining impacts. Since pyrite (FeS_2) is the most commonly occurring mineral that can produce acidic drainage, then the TMDL for iron is also used as a surrogate TMDL for pH in Fisher Creek. Unfortunately, this approach is only supported partially by results from Kimball et al. (1999). For example, pH averages about 4 where levels of filtered (dissolved) and total iron are all below 235 ug/l, although these iron values do go up above 45,700 ug/l in association with a subsequent pH drop to 3.1 further downstream below the Glengary Adit. Upstream of the Glengary Adit where iron values are relatively low, filtered and total copper values are elevated at or above 570 ug/l. For this reason, copper values are also used as a surrogate TMDL for pH, meaning that it is assumed that both the copper and iron TMDLs will need to be satisfied to meet the pH targets in Tables 3-6 through 3-8. For example, the mean low flow iron TMDL of 0.51 lb/day at SW3, and the mean low flow copper TMDL of 0.007 lb/day at SW3 represent loading conditions whereby pH values are expected to comply with Montana Water Quality Standards.

Meeting the copper and lead TMDLs associated with the numeric water quality targets is expected to satisfy the sediment toxicity targets for both streams. As metal loading is reduced to TMDL levels, the existing fine sediments with metals contamination will likely flush through the system at high flows as they have probably been doing over the years, the difference being that they will start being replaced by fewer and cleaner fine sediment deposits.

Meeting all of the metals and pH TMDLs is expected to result in meeting the target associated with macroinvertebrate and periphyton communities being at 75% or greater in comparison to a reference stream.

Tables 3-6 through 3-8 also provide the percent total load reduction needed to meet the daily load associated with the Table 3-5 targets. These calculations were made based on existing concentrations and target concentrations. The data used for these calculations were obtained from the database on the Maxim website using sampling events where metals concentrations and corresponding stream flow data were available. Typically only a maximum of one representative high flow and one representative low flow set of data per year, where available, were used. Tables D-3 - through D-5 in Appendix D provide a summary of the data used for these tables.

For Fisher Creek, note that copper requires the greatest percent reduction in total load at greater than 99% for low and high flow conditions at SW3 and 96% at low and high flow conditions at SW4. Iron, manganese, cadmium, aluminum, zinc and lead also require very high percent load reductions of greater than 50% under low and/or high flow conditions, particularly at upstream sample location SW3. Note that many metals have only occasional detections above the target levels during low and/or high flow conditions, particularly at the more downstream sample location SW4, making the calculation of percent reductions based on mean (average) values difficult.

For the Clarks Fork River, copper still requires the greatest percent reduction in total load at 63% for the low flow condition and 88% for the high flow condition. No other metal has consistent detections above target values, making the calculation of percent reductions based on mean (average) values difficult. As previously discussed, there tend to be more detections above target levels at higher versus lower flows for most metals. This tendency toward high flow problems may be partly due to loading at low flow conditions and the subsequent re-suspension of precipitants from the streambed during these higher flows.

It is important to note that a given decrease in metal loading at an upstream location does not always directly result in the same loading decrease downstream, particularly during lower flows since chemical reactions associated with changing pH and related metal solubility can determine downstream concentrations. Nevertheless, any load reductions at low flow can significantly contribute to overall yearly loading reductions since there would be a significant reduction in the total amount of precipitated metals that could be re-suspended and transported downstream at higher flows.

3.3.1.3 Performance Based Load Allocation Approach for Metals and pH

A performance based allocation approach is used for metals and pH load allocations. This approach relies on detailed plans and practices that will be developed and applied to all significant mining sources impacting Fisher Creek and the Clarks Fork River. The *Petition Report* (Stanley, 1999) and the *Final Overall Project Work Plan for the New World Mining District Response and Restoration Project* (Maxim, 1999) provide details concerning the overall restoration strategy for District and some non-District property within the Cooke City Planning Area. The *Petition Report* specifically includes schedules and detailed site descriptions and anticipated restoration activities. The *Final Work Plan* further describes the process whereby potential pollutant sources (e.g. mine dumps, adits, etc.) are evaluated and restoration approaches are analyzed in detail and undergo stakeholder review and comment prior to selection of a final restoration approach for each location of concern. The information is then documented in an annual work plan, which may address one or more locations where restoration is planned over the coming year. This process continues every year with the goal of achieving cleanup by 2014 as required by the Temporary Water Quality Standards. *The New World Mining District Response and Restoration Project: Project Summary, 2001*(Maxim, 2001b) also describes the restoration planning and implementation process for the District.

Table 3-5. Metals and pH Water Quality Restoration Targets for Fisher Creek and the Clarks Fork River

Stream(s)	Pollutant	Target(s)	Limiting Beneficial Use
Fisher Creek and Clarks Fork River	Copper[1]	2.8 ug/l (high flow) 4.2 ug/l (low flow) sediment concentrations at non-toxic levels	Aquatic Life (chronic) Aquatic Life (chronic) Aquatic Life
Fisher Creek and Clarks Fork River	Cadmium[1]	0.10 ug/l (high flow) 0.14 ug/l (low flow)	Aquatic Life (chronic) Aquatic Life (chronic)
Fisher Creek and Clarks Fork River	Lead[1]	0.54 ug/l (high flow) 0.99 ug/l (low flow) sediment concentrations at non-toxic levels	Aquatic Life (chronic) Aquatic Life (chronic) Aquatic Life
Fisher Creek and Clarks Fork River	Zinc[1]	37 ug/l (high flow) 55 ug/l (low flow)	Aquatic Life (acute & chronic) Aquatic Life (acute & chronic)
Fisher Creek	Iron	300 ug/l no visible streambed deposits associated with controllable human causes	Drinking Water (domestic use) Aquatic Life/Aesthetics
Fisher Creek	Manganese	50 ug/l	Drinking Water (domestic use)
Fisher Creek	Aluminum	- 87 ug/l (dissolved aluminum in pH range of 6.5 to 9.0; outside of this range there is no applicable dissolved aluminum target) - no precipitants causing visible turbidity at low flow conditions	Aquatic Life (chronic) Aquatic Life/Aesthetics
Fisher Creek and Clarks Fork River	Silver[1]	0.37 ug/l (high flow) 0.84 ug/l (low flow)	Aquatic Life (acute) Aquatic Life (acute)
Fisher Creek and Clarks Fork River	PH	6.0 to 9.0	Aquatic Life
Fisher Creek & Clarks Fork River	Metals & pH	macroinvertebrate and periphyton communities at 75% or greater of reference stream conditions	Aquatic Life

1 All targets for this pollutant are estimated based on predicted hardness values after completion of restoration activities, actual values will be determined by hardness as defined in Appendix A

Table 3-6. Fisher Creek TMDL and Load Reduction Examples for Metals and pH at Typical High and Low Flow Conditions at SW3

Pollutant	Primary Target (ug/l)	Mean Low Flow (0.32 cfs) TMDL (lb/day)	Mean High Flow (9.4 cfs) TMDL (lb/day)	% Total Load Reduction Needed to Meet TMDLs and Targets
Copper	4.2 (low flow) 2.8 (high flow)	0.007	0.14	>99% (low flow); >99% (high flow)
Cadmium	0.14 (low flow) 0.10 (high flow)	0.0002	0.005	87% (low flow); 50% (high flow)
Lead	0.99 (low flow) 0.54 (high flow)	0.0017	0.027	86% (low flow); 89% (high flow)
Zinc	55 (low flow) 37 (high flow)	0.094	1.86	69% (low flow); 24% (high flow)
Iron	Prevent objectionable streambed deposits (low flow) 300 ug/l (all flows)	0.51	15	96% (low flow); 92% (high flow)
Manganese	50 (all flows)	0.085	2.51	96% (low flow); 79% (high flow)
Aluminum	87 (dissolved, all flows) [1] no precipitants causing visible turbidity at low flow conditions	0.15 (dissolved) 0.34 (total recoverable; based on 200 ug/l concentration goal)	0.40 (dissolved)	98% (dissolved, low flow); 95% (dissolved high flow); 95% (total recoverable, low flow)
Silver	0.84 (low flow) 0.37 (high flow)	0.0014	0.018	--% (low flow) [2]; --% (high flow) [2]
pH	6.0 to 9.0 (all flows)	0.51 lb/day iron load 0.007 lb/day copper load (surrogate TMDLs)	15 lb/day iron load 0.14 lb/day copper load (surrogate TMDLs)	96% (iron, low flow); 92% (iron, high flow); >99% (copper, low flow); >99% (copper, high flow)

Notes:
1 Target and TMDLs only apply if pH is in the range of 6.0 to 9.0
2 The limited number of detections makes it difficult to calculate a % reduction

Table 3-7. Fisher Creek TMDL and Load Reduction Examples for Metals and pH at Typical High and Low Flow Conditions at SW4

Pollutant	Primary Target (ug/l)	Mean Low Flow (1.5 cfs) TMDL (lb/day)	Mean High Flow (73 cfs) TMDL (lb/day)	% Total Load Reduction Needed to Meet TMDLs and Targets
Copper	4.2 (low flow) 2.8 (high flow)	0.034	1.1	96% (low flow); 96% (high flow)
Cadmium	0.14 (low flow) 0.10 (high flow)	0.001	0.039	52% (low flow); --% (high flow) [2]
Lead	0.99 (low flow) 0.54 (high flow)	0.008	0.21	0% (low flow) [3]; 85% (high flow)
Zinc	55 (low flow) 37 (high flow)	0.44	14.4	--% (low flow) [4]; --% (high flow) [5]
Iron	Prevent objectionable streambed deposits (low flow) 300 ug/l (all flows)	2.4	117	96% (low flow); 64% (high flow)
Manganese	50 (all flows)	0.40	19.5	58% (low flow); --% (high flow) [5]
Aluminum	87 (all flows) [1] no precipitants causing visible turbidity at low flow conditions	0.70 (dissolved) (total recoverable; based on 200 ug/l concentration goal)	3.12 (dissolved)	--% (dissolved, low flow)[5]; --% (dissolved, high flow)[5]; 26% (total recoverable, low flow)
Silver	0.84 (low flow) 0.37 (high flow)	0.007	0.14	--% (low flow) [2]; --% (high flow) [2]
pH	6.0 to 9.0 (all flows)	2.4 lb/day iron load 0.034 lb/day copper load (surrogate TMDLs)	117 lb/day iron load 1.1 lb/day copper load (surrogate TMDLs)	96% (iron, low flow); 64% (iron, high flow) 96% (copper, low flow) 96% (copper, high flow)

Notes:
1 Target and TMDL only apply if pH is in the range of 6.0 to 9.0
2 The limited number of detections makes it difficult to calculate a % reduction
3 A lack of detections at low flow imply that lead is only a higher flow concern
4 Although the average reduction in load computes to 0% for zinc at low flow, the fact that some values exceed the target is sufficient to require TMDL development
5 The limited number or lack of values at levels above the example target or surrogate value for TMDL development makes it difficult to calculate a % reduction

Table 3-8. Clarks Fork River TMDL and Load Reduction Examples for Metals at Typical High and Low Flow Conditions at SW6)

Pollutant	Primary Target (ug/l)	Mean Low Flow (3.7 cfs) TMDL (lb/day)	Mean High Flow (173 cfs) TMDL (lb/day)	% Total Load Reduction Needed to Meet TMDL
Copper	4.2 (low flow) 2.8 (high flow)	0.08	2.6	63% (low flow); 88% (high flow)
Cadmium	0.14 (low flow) [1] 0.10 (high flow)	0.003	0.09	--% (low flow)[1]; --% (high flow)[3]
Lead	0.99 (low flow) [2] 0.54 (high flow) [2]	0.019	0.50	--% (low flow) [3]; --% (high flow) [3]
Zinc	55 (low flow) [1] 37 (high flow)	1.1	34	--% (low flow)[1]; --% (high flow)[3]
Silver	0.84 (low flow) 0.37 (high flow)	0.02	0.34	--% (low flow)[1]; --% (high flow)[1]
pH	6.0 to 9.0 (all flows)	6 lb/day iron load 0.08 lb/day copper load (surrogate TMDLs)	277 lb/day iron load 2.6 lb/day copper load (surrogate TMDLs)	--% (iron, low flow) [3]; --% (iron, high flow) [3] 63% (copper, low flow) 88% (copper, high flow)

Notes:

1 Cadmium, and zinc are not considered low flow concerns, although TMDL examples are provided anyway.

2 These targets represent conditions where sediment toxicity problems can be avoided

3 The limited number or lack of detections above the target or TMDL value of concern makes it difficult to calculate a % reduction

Overall, a total of 18 source areas have been identified in the District. The source areas that involve Fisher Creek and the Clarks Fork River, including a summary of the general activities that are planned as well as some potential restoration actions, are discussed below (reference Figures 3-1 and 3-2).

•District Property	Includes all property or interest relinquished by CBMI. Activities will include: surveying the District for additional sources; characterize chemistry, thickness, and quantity of sources (waste rock dumps or tailings) through borehole drilling; identify and investigate potential waste rock disposal sites; identify potential borrow sources; survey cultural resources; and monitor surface and ground water resources. Restoration activities can include activities such as removal to the repository site and/or drainage control.
•Glengary Adit/Shafts	Complete the hydrologic evaluation of the mine workings; determine control options for reducing adit inflows; rehabilitate adit as necessary to evaluate source control measures; characterize waste rock dumps; evaluate source control and water treatment options; install and maintain stormwater sediment control; insure that all capped boreholes are secure; monitor and maintain revegetated areas; and monitor water diversion system and erosion control measures.
•Spalding Tunnels	Includes the underground workings north of the Como Basin (also know as the upper Glengary workings) and associated waste rock material. Activities will include: completion of the hydrologic evaluation of the mine workings; evaluate source control options, water treatment and adit closure options; rehabilitate adits as necessary to evaluate source control measures; characterize waste rock dumps; install and maintain stormwater sediment control; monitor and maintain revegetated areas; and monitor water diversion system and erosion control measures.
•Como Basin	Includes the disturbed areas and waste rock material in and around the topographic depression at the headwaters of Fisher Creek. Likely activities include: insuring that all underground workings are identified; evaluate source control measures and water treatment options including evaluating installation of caps over certain areas and shafts; install and maintain stormwater sediment control; monitor and maintain revegetated areas; insure that all capped boreholes are secure; and monitor water diversion system and erosion control measures.

•Gold Dust Adit	Includes the underground workings and associated waste rock material and surface disturbances comprising the Gold Dust mine. Activities are likely to include the following: complete the hydrologic evaluation of the mine workings; insuring that all underground workings are identified; rehabilitate adits if necessary to evaluate source control options; evaluate source control, water treatment and adit closure options; characterize waste rock dumps; install and maintain stormwater sediment control; install erosion control measures; monitor and maintain revegetated areas; and monitor water diversion system and erosion control measures.
•New Chicago Mill Site	Includes the surface disturbances and mill waste in and around the historic White smelter site near the Fisher Creek road crossing. Disturbances and mine waste at this site will be characterized to determine necessary removal actions.
•Fisher Creek	Encompasses the general area defined by the Fisher Creek drainage basin and includes miscellaneous waste rock piles and prospects. Disturbances and mine waste in this source area will be characterized to determine necessary removal actions.
•East Henderson Mountain	Encompasses the general area of the east and northeast slopes of Henderson Mountain and includes miscellaneous adits, shafts, waste rock piles, and prospects. Disturbances and mine waste in this source area will be characterized to determine necessary removal actions.
•Sheep Mountain - FCT-12	Encompasses the west and south west slopes of Sheep Mountain including the Tredennic adit and waste rock piles and miscellaneous short adits and prospect pits. Disturbances and mine waste in this source area will be characterized to determine necessary removal actions.
•"Other" Reeb Property	Includes other property owned or controlled by Margrete Reeb including the silver claims adit, prospects and waste rock above Goose Creek, miscellaneous short adits and waste rock piles on Henderson Mountain. Disturbances and mine waste in this source area will be characterized to determine necessary removal actions.
•Road Systems	Roads within or accessing District Property will be evaluated to determine which roads should be closed and which roads will be used during removal actions. In addition, best management practices typically associated with drainage

improvements and other erosion controls will likely be pursued on roads and trails where closure is not consistent with overall forest recreational goals.

•Wetland, Stream Bank — Includes contaminated material deposited along stream thalwegs and Transported Sources and bog material with elevated metal concentrations. Disturbances in this source area will be characterized to determine necessary removal actions.

Figure 3-1 shows the locations of most or all of the mine disturbances in the Fisher Creek and Clarks Fork River drainages. These mine disturbances are all addressed under one or more of the above categories. For example, the Homestake Mine Dump and Pit may not be specifically addressed above, but it does fall under either the overall category of District Property or Fisher Creek, and will therefore be addressed as discussed above.

Note that the Chicago Mill Site is specifically addressed as a separate source category in the above list, even though is located predominately on private, non-District property as shown by Figure 3-1. The Scotch Bonnet Dumps represent another similar situation. Characterization work completed thus far indicates that these are probably not significant sources of metals contamination to surface waters (personal discussion with Forest Service Project personnel).

Figure 3-2 shows the road network that is discussed above under the Road Systems category. Erosion control efforts focused on the mine disturbances identified in Figure 3-1, as well as some of the roads and trails in the vicinity of the mine disturbances, will further reduce metal loading to both streams.

Some of the potential sources of metals to Fisher Creek and the Clark Fork River include erosion from roads and other disturbed areas and sources located on non-District Property. The *Consent Decree and Settlement Agreement* (United States District Court for the District of Montana Billings Division, 1998) provides further restoration guidance for all sources in the Daisy, Fisher, and Miller Creek drainages as well as sources within the whole New World Mining District. Per the Natural Resources Working Group for the New World Mining District Response and Restoration Project, there are two categories of work that can be done (Natural Resources Working Group Meeting Summary, June 19, 2002). These are:

- Category A - hazardous substances (i.e. mine waste) that are on District Property and non-hazardous substances (e.g. principally sediment from roads) on District Property. Work can be done prior to the receipt of the Notice of Completion from the United States Government.

- Category B – after receipt of the Notice of Completion, work can address other hazardous and non-hazardous sources on non-District Property.

It is assumed that all significant metals and pH related sources, other than natural background sources, to Fisher Creek and the Stillwater River are “Category A” or

"Category B" type sources that will be addressed as part of the New World Restoration efforts. The "Category A" sources, which are located on District Property (reference Figures 3-1 and 3-2), will be addressed as part of the consent decree requirements for a notice of completion. Any significant "Category B" sources located on either private or Forest Service lands will be addressed within the budget constraints of the New World restoration project after issuance of the notice of completion. If there is not adequate budget, then a load will be allocated to each significant source to reflect loading conditions needed to ensure that water quality targets would be met once each new allocation is satisfied.

It is assumed that all New World restoration activities will be implemented in a manner that represents all reasonable land, soil, and water conservation practices and therefore will satisfy the intent of Montana's Water Quality Standards for metals and pH. This includes appropriate implementation monitoring and maintenance of restoration efforts to ensure success.

As previously discussed, once metals loading approaches TMDL levels the existing fine sediments with metals contamination will likely flush through the system at high flows as they have probably been doing over the years, the difference being that they will start being replaced by fewer and cleaner fine sediment deposits. Note that the restoration work for the "Wetland, Stream Bank" source area is intended to verify this assumption and address significantly high levels of metals contaminants in stream sediments and floodplain material if they did not flush through the system as anticipated.

Section 5.0 in this document summarizes some additional components of the overall restoration strategy for Fisher Creek and the Clarks Fork River.

3.3.2 Sediment Restoration Targets, TMDLs and Allocations

3.3.2.1 Sediment Targets

For sediment, target development is based on criteria currently found *within Appendix A of Water Quality Assessment Process and Methods* (MDEQ, 2000). The Appendix A document provides guidelines for making beneficial use support determinations, and essentially provides a process for interpreting narrative water quality standards, such as those that exist for sediment, under certain conditions of data availability.

The are two water quality restoration targets for sediment in Fisher Creek, both of which are presented below:

- Periphyton and macroinvertebrate biota at 75% of reference condition based on established protocols for evaluating sediment impairment conditions

AND

- The habitat conditions must represent 75% of the reference condition by allowing no greater than a 25% average increase above reference condition percent fines data for all sizes less than D_{50}.

The first target is based on biological data since ideally this would best represent aquatic life beneficial use support. The second target is developed as method to directly measure sediment impacts on habitat conditions relative to a reference stream. Meeting this habitat condition is assumed to support biota at a 75% level of reference conditions from a sediment impact perspective. The sizes less than D_{50} are chosen to ensure that particle sizes generally associated with aquatic life impacts, such as 6.35 mm and smaller, are the primary focus.

At this time, a reference stream condition and recent pebble count data are not available to provide comparisons as was done for Daisy Creek and the Stillwater River. Because percent fines curves can vary from time to time at the same locations, any comparisons to reference conditions curves must be made using measurements from the same day for each water body, including the reference stream. Measurements to evaluate status toward meeting the sediment target should be taken during the lower flow summer or fall season after spring runoff conditions. A similar approach in comparing biota between Fisher Creek to reference stream conditions also applies. At a minimum, the identification of a reference stream will be necessary as restoration efforts progress toward completion (i.e. in about 5 or more years) in order to evaluate overall progress and determine whether or not the target conditions will be satisfied.

Possible confounding effects of potentially long term elevated metal concentrations in the water column and in sediments of Fisher Creek may make it difficult to meet the biota target due to difficulty in finding a similarly impacted reference stream. For this reason, the sediment targets will be evaluated at least every five years for suitability and may be modified based on identification of a more suitable reference stream and/or identification of a better indicator of habitat conditions needed to support aquatic life. The sediment targets could also be modified to represent anticipated conditions associated with the implementation of sediment control and mine restoration activities in the Fisher Creek drainage area in a manner that represents the application of all reasonable land, soil and water conservation measures.

3.3.2.2 Sediment TMDLs and Load Allocations

As previously discussed under Source Characterization (Section 3.2.3), the current modeled annual percent sediment yield above natural background for Fisher Creek has been calculated at 34%, which amounts to 13 tons per year (tons/yr) of sediment above and beyond the natural background of load of 38 tons/yr. Based on expected erosion control efforts associated with mine disturbances, in addition to road improvements, it is envisioned that the modeled annual percent greater than natural background loading to Fisher Creek will be reduced from 34% to 25% or less (discussions with Mark Story, USFS). This would mean that the modeled 13 tons/yr of sediment from roads and mining activities would be reduced to 9.5 tons/yr or less. This 9.5 tons per year load represents a yearly load allocation for the combined categories roads and mine disturbances in the Fisher Creek drainage. The sediment load of 9.5 tons/yr above natural background plus the natural background load of 38 tons/yr equals 47.5 tons/yr. This modeled 47.5 tons/yr represents the total maximum yearly load and represents a surrogate TMDL for Fisher

Creek. It is assumed that this sediment load, and associated reduction to meet the load, will result in conditions that will meet the sediment targets.

Table 3-9 provides a summary of the load allocations and associated percent reductions for the major sediment load categories for Fisher Creek. Note that a performance based approach is not used for sediment load allocations since information on load contributions from specific sources is available. Instead, the Sediment load allocations are based on anticipated load reductions associated with the combined categories of roads and mine disturbances, as shown in Table 3-9, with most reductions anticipated from road restoration efforts (discussion with Mark Story, USFS).

It is important to note that the actual annual sediment variation can be an order of magnitude greater due to climatic variability, whereas the allocation and TMDL are based on modeled sediment yields assuming average annual precipitation.

Table 3-9. Modeled Sediment Load Allocations for Fisher Creek

Source Category	Existing Load (tons/yr)	Load Allocation (tons/yr)	% Reduction in Load by Source Category
Natural Background	**38**	**38**	**0%**
Roads & Mine Disturbances	**13**	**9.5**	**27%**

Because there is uncertainty associated with the assumption that the Table 3-9 load allocations will result in meeting one or more sediment targets, an adaptive management or phased approach will be pursued. As restoration efforts continue and reductions in sediment yield are achieved, sediment measurements will be taken to evaluate progress toward meeting targets. If it looks like greater reductions in sediment loading are needed, then a new TMDL and new load allocations will be developed in recognition of the need to further reduce sediment yield in the Fisher Creek drainage. Any modifications to the sediment targets, as discussed above under Section 3.3.2.1, will also be incorporated into this adaptive management approach.

3.4 Metals Impairment for the Clarks Fork of the Yellowstone in Wyoming

The Clarks Fork River across the border from Montana is also identified as not supporting Wyoming Water Quality Standards for copper, silver, and cadmium. The Wyoming standards for these three metals are based on dissolved versus total recoverable concentrations (Wyoming Water Quality Rules and Regulations, 2001). Table 3-10 shows the applicable Montana water quality standards at the border on the Montana side, and the applicable Wyoming water quality standards at the border on the Wyoming side. These standards are all computed using a hardness of 25 mg/l $CaCO_3$, which is an appropriately conservative value to use for this river. Note that the levels are similar. Where Montana numbers are higher, they are still likely to be more protective since total recoverable levels are often higher than dissolved levels. In other words, if the total recoverable metal concentration in a stream was 2.8 ug/l, then the dissolved portion or concentration would be less than 2.7 ug/l based on the trend from numerous sample results for the Cooke City TMDL Planning Area.

Table 3-10. Comparison of Montana and Wyoming Standards

Metal	Aquatic Life Support Criteria	Montana Total Recoverable Metal Standard (ug/l)	Wyoming Dissolved Metal Standard (ug/l)
Copper	Chronic	2.8	2.7
Copper	Acute	3.8	3.7
Cadmium	Chronic	0.10[2]	0.80
Cadmium	Acute	0.52[2]	0.95
Silver[1]	Acute	0.37	0.32

Notes:
1. Silver does not have a chronic aquatic life support standard
2. Montana cadmium values reflect new EPA determinations for aquatic life support

There is a USGS station (#06205450) located on the Clarks Fork in Wyoming near the Montana Wyoming border. Below is a summary of dissolved copper, cadmium, and silver results for sample information collected between 1990 and 1999.

Dissolved Copper: Out of 36 samples, 11 were below a 1 ug/l detection limit. All detections were between 1 and 8 ug/l, with higher values tending to occur with some of the older data. A total of 10 detections exceeded Wyoming's chronic aquatic life standard, and three exceeded the acute aquatic life standard. There is an apparent trend of higher values during higher flow events for all data collected from 1992 through 1999.

Dissolved Cadmium: Out of 36 samples, 27 were below a 1 ug/l detection limit, and 3 were below an 8 ug/l detection limit. There were six detections ranging from 1 to 3 ug/l, all of which exceed the Wyoming aquatic life support standards associated with both chronic and acute conditions. The highest flow events had detections, but detections also occurred during lower flow periods.

Dissolved Silver: Out of 36 samples, 27 were below a 1 ug/l detection limit, and 3 were below a 4 ug/l detection limit. There were six detections ranging from 1 to 2 ug/l, all of which exceed the Wyoming aquatic life support standard associated with acute conditions. It is difficult to identify flow related trends. The past 17 samples, which include all data between 1996 and 1999, are below detection.

Between Fisher Creek and the Montana-Wyoming border (border), the Broadwater River enters the Clarks Fork and greatly increases the flow (Figure E-2). For example, on 9/22/93 the Broadwater River at sample location was flowing at 23.5 cfs, whereas the Clarks Fork River at SW6, which is upstream of the Broadwater River, was flowing at 4.2 cfs. The dissolved copper concentration in the Clarks Fork was at 13 ug/l (0.29 lb/day), and was less than the detection level of 1 ug/l in the Broadwater River. Two days later, the flow in Wyoming at the USGS station was measured at 26 cfs with a dissolved copper concentration of 2 ug/l. This equates to a load rate of 0.28 ug/l, which is nearly identical to the 0.29 lb/day load at SW6. Unfortunately, this appears to be the only time frame where such loading comparisons can be calculated.

The Maxim database (Maxim, 2001a) does provide limited sample results (7) for the Broadwater River at location BW-1 for the 1990 through 1993 time period. Hardness values are typically below 10 mg/l $CaCO_3$. The data indicates total recoverable copper is at levels (up to 10 ug/l) that may be of concern from a Montana beneficial use support perspective. The 3 available dissolved copper results are all below 1 ug/l. All 7 total recoverable cadmium results are below 0.1 ug/l except for one at 0.7 ug/l, which also indicates an aquatic life concern. The 3 available dissolved cadmium results are all below detection. All 7 total recoverable silver results are below detection, except for one at 1.2 ug/l, which again indicates an aquatic life concern. Of the 2 available dissolved silver values, two are below detection, and one is at 0.9 ug/l, which by itself is of concern from a Wyoming standard perspective given that the Broadwater is most of the flow for the Clarks Fork River just below the border.

Potential sources of these metals from mining or other human caused conditions in the Broadwater River drainage are not apparent at this time, and increased loads could be associated with natural background conditions. It appears as though efforts in Montana to reduce loading to the Clarks Fork River by addressing the mine sources and erosion sources identified by Figure 3-1 and 3-2 will primarily address metals concerns in the Clarks Fork River near the border and into Wyoming. Nevertheless, there remains the possibility of occasional elevated levels of some metals associated with controllable sources in the Broadwater drainage.

It appears as though the targets and TMDLs developed for the Clarks Fork River in Montana can also serve as the metals TMDLs and targets for the section of the Clarks Fork River within Wyoming. This would be protective of Wyoming's beneficial uses, satisfy Wyoming water quality standards, and be protective of the National Wild and Scenic River designation for this stream segment. The performance based allocations for Fisher Creek and the Clarks Fork River will likely be sufficient to protect this stream segment within Wyoming. The lack of apparent metals sources in Wyoming further supports this conclusion. Nevertheless, additional analyses will need to be pursued within the Broadwater River drainage to determine whether or not there is a need for additional load allocations and restoration planning for the lower sections of the Clarks Fork River in Montana, the section of the Clarks Fork River in Wyoming, and for the Broadwater River drainage. This effort should include potential source identification and characterization, as well as additional data to better characterize metal loads to the Clarks Fork River from drainages other than Fisher Creek.

SECTION 4.0
MILLER CREEK AND SODA BUTTE CREEK WATER QUALITY RESTORATION

4.1 Impairment Conditions

Miller Creek and Soda Butte Creek are both impacted from elevated metals concentrations. Several reports and data sources identify impacts to beneficial uses as discussed below.

4.1.1 Metals Impairment Conditions

There are several pertinent sources of water quality and sediment chemistry data. Recent surface water and sediment sample results for both water bodies are reported in *The Effects of Metal Mining and Milling on Boundary Waters of Yellowstone National Park* (Nimmo et al 1999) and in the *Final Site Evaluation Report for the McLaren Tailings Site; Cooke City, Montana* (Pioneer, 2001a)). In addition, the Maxim website (Maxim, 2001a) provides significant data for both water bodies.

A tracer injection and synoptic sampling study was performed for Miller Creek during 2000 low flow conditions (discussion with Tom Cleasby, 2001). The final report is still undergoing reviews, but the sampling results have been used to assist in the development of this WQRP. The study includes water quality and sediment chemistry data for Miller Creek as well as many of the seeps and small tributaries feeding into Miller Creek. The USGS also performed a synoptic sampling study for Soda Butte Creek during low flow conditions in 1999. The results and conclusions from this study are included within a final report (Boughton, 2001) that also includes a retrospective analysis of previous research. In addition, the USGS has been collecting samples since 1999 at Gaging Station 06187915 (USGS, 2001), which is located at or very close to sample location SBC4 just upstream of Yellowstone National Park (reference Figure 1-3).

The above referenced information and other reports show that conditions in Miller Creek do not fully support the beneficial uses associated with a B-1 classification and do not comply with applicable B-1 standards for copper, iron, cadmium, lead, manganese, zinc, and possibly aluminum. Copper is the only metal that consistently exceeds the standards, generally during moderate to high flow conditions. All other metals appear to primarily be a high flow problem, with additional concerns associated with elevated copper and lead levels in sediments.

The above referenced information and other reports show that conditions in Soda Butte Creek do not fully support the beneficial uses associated with a B-1 classification and do not comply with applicable standards for copper, iron, manganese, lead and aluminum. Copper sampling results indicate that in addition to water chemistry there are also elevated levels of copper in stream sediments causing negative impacts to aquatic life just downstream of the McLaren Tailings and McLaren Mill Site and sometimes throughout Soda Butte Creek from the McLaren Tailings to Yellowstone National Park.

Tables 4-1 and 4-2 provide summaries of the impairment concerns associated with Miller Creek and Soda Butte Creek respectively. The Table 4-1 metals data for Miller Creek are from samples taken from or near location SW5 (Figure 1-3) at the mouth of Miller Creek. The SW5 monitoring results are consistent with the monitoring results from sample location SW2, located upstream on Miller Creek. SW2 has recently become the favored monitoring site for evaluating Miller Creek water quality in relation to New World Mine restoration work. Part of the justification for moving the sample location was a lack of flow at SW5 during late fall sampling.

The Table 4-2 metals data for Soda Butte Creek are representative of sample results downstream of the McLaren Tailings Area (which includes the McLaren Mill Site area). The information is from samples taken adjacent to or just below the tailings at or near sample location SBC-2, from samples taken just upstream of Yellowstone National Park at or near sample location SBC-4, and from samples taken at locations between SBC2 and SBC4. The sampling results downstream of the McLaren Tailings capture impacts from these tailings as well as impacts from Miller Creek, which enters Soda Butte Creek across from the tailings (Figure 1-3). Sample results for the upper section of Soda Butte Creek above the McLaren Tailings Area all show metal values that support the MDEQ decision to identify this stretch of stream as fully supporting beneficial uses (MDEQ, 2000 303(d) List).

An additional significant threat to Soda Butte Creek exists due to the McLaren Tailings dam and the potential for failure since the tailings dam is located adjacent to Soda Butte Creek where high flows can erode and saturate the dam causing an unacceptable risk of dam failure. Such a failure could cause significant damage to the physical habitat within Soda Butte Creek and release very large amounts of contaminated material that would likely deposit all along Soda Butte Creek and Lamar River valleys within Montana and within Yellowstone National Park.

There are drinking water wells in the Cooke City area where some residents obtain their domestic water from an alluvial system that is interconnected to Soda Butte Creek flows. The retrospective analysis of previous research (Boughton, 2001) provides a summary of previous ground water work and metals sampling. Based on this previous work, metal concentrations in wells are currently below levels of concern in area ground water supplies, presumably due to high levels of dilution in the ground water system and other hydrogeologic factors .

Appendix B provides a descriptive water quality summary for each of the metals of concern as they relate to impairment determinations.

4.1.2 Sediment (Suspended Solids) Impairment Decision

Based on a 1989 evaluation by MDEQ staff, the Montana 1996 303(d) List includes suspended solids as a cause of impairment in the first 5 miles of Soda Butte Creek downstream from the McLaren Tailings repository. The MDEQ water quality specialist responsible for beneficial use determinations in the Yellowstone region has subsequently determined that Soda Butte Creek is not impaired as a result of suspended solids.

Table 4-1. Miller Creek Metals Impairment Summary (Total Recoverable Metals Data from Sample Location SW5)

Pollutant	Sampling Results	Water Quality Standard Concern	Water Quality Standards Reference(s)
Copper	1 - 200 ug/l	- consistently > 4.7 ug/l chronic aquatic life (during high flow)[1] - sometimes > 7.3 ug/l chronic aquatic life (during low flow)[1] - often > 6.6 ug/l acute aquatic life (during high flow)[1] - results in elevated copper levels in sediment	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d)
Iron	< 30 - 3220 ug/l	- consistently > 1000 ug/l chronic aquatic life (during high flow only) - consistently > 300 ug/l domestic/drinking water use (higher flows)	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d)
Manganese	< 10 - 130 ug/l	- consistently > 50 ug/l domestic use (during high flow only)	17.30.623(2)(h)(i) - WQB-7
Aluminum	< 100 - 1800 ug/l (total recoverable)	- lack of corresponding dissolved aluminum data at high flow conditions when total recoverable values are very high leaves open the possibility of a water quality concern at high flow	17.30.623(2)(h)(i) - WQB-7
Zinc	< 10 - 460 ug/l	1 detection > 61 ug/l chronic & acute aquatic life (during high flow)[1] 2 detections > 94 ug/l chronic & acute aquatic life (during low flow)[1]	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d)
Cadmium	< 0.1 – 0.4 ug/l	- > 0.15 chronic aquatic life (during very high flow only)[1]	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d)
Lead	< 2 - 22 ug/l limited detections	- sometimes > 1.2 ug/l chronic aquatic life (during high flow)[1] - sometimes > 2.2 ug/l chronic aquatic life (during low flow)[1] - one value > 15 ug/l human health standard - results in elevated lead levels in sediment	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d)

Notes:
1. Standards reflect adjustments for water hardness, which varies during lower flow periods (generally late summer or fall) and higher flow periods (generally spring/early summer runoff) in Miller Creek; the lower flow hardness value used for Miller Creek is 75 mg/l as calcium carbonate; and the higher flow hardness value is 45 mg/l as calcium carbonate.

Table 4-2. Soda Butte Creek Metals Impairment Summary

Pollutant	Sampling Results	Water Quality Standard Concern	Water Quality Standards Reference(s)
Copper	< 1- 22 ug/l	- sometimes > 4.7 ug/l chronic aquatic life (during high flow)[1] - sometimes > 7.3 ug/l chronic aquatic life (during low flow)[1] - sometimes > 6.6 ug/l acute aquatic life (during high flow)[1] - results in elevated copper levels in sediment	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d)
Iron	150 - 6260 ug/l	> 1000 ug/l chronic aquatic life (during high and low flows) - consistently > 300 ug/l domestic/drinking use - consistently forms objectionable streambed deposits (downstream of McLaren Tailings)	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(a) 17.30.637(1)(d)
Manganese	< 10 - 210 ug/l	> 50 ug/l domestic use	17.30.623(2)(h)(i) - WQB-7
Aluminum	< 1 - 200 ug/l (dissolved)	two values > 87 ug/l chronic aquatic life, indication is that one stream reach is consistently above this value at low flow	17.30.623(2)(h)(i) - WQB-7
Lead	< 1 - 58 ug/l	- sometimes > 1.2 ug/l chronic aquatic life (during high flow) [1] - one value > 30 ug/l acute aquatic life (during high flow)[1] - two values > 15 ug/l human health standard	17.30.623(2)(h)(i) - WQB-7

Notes:
1 Standards reflect adjustments for water hardness, which varies during lower flow period (generally late summer or fall data) and higher flow periods (generally spring/early summer) in Soda Butte Creek; the low flow hardness value used for Soda Butte Creek is 75 mg/l as calcium carbonate; and the higher flow hardness values is 45 mg/l as calcium carbonate.

The supporting documentation for the 1996 listing includes discussions in Mohrman et al. (1988) and a personal observation by the MDEQ reviewer. Mohrman et al. reported heavy sediment load contributions to Soda Butte Creek from tributaries. Mohrman et al. and the reviewer both noted that the McLaren Tailings were a source of sediment to Soda Butte Creek at that time.

Through onsite surveys and discussions with USFS, MDEQ professional staff determined that the relatively steep, erosive tributary watersheds discussed in Mohrman et al. naturally carry extremely heavy sediment loads. In 1989, the EPA used a Superfund emergency response action to renovate the McLaren Tailings impoundment and the adjacent reach of Soda Butte Creek to prevent erosion and possible discharge of tailings during floods (Nimmo, 1999). In August 2001, the MDEQ professional staff inspected the site and did not find significant erosion from the McLaren Tailings repository. MDEQ staff determined that even directly below the McLaren Tailings repository, the naturally high sediment load appears to be the primary factor determining substrate composition and channel morphology.

For the above reasons, suspended solids/sediment is no longer pursued as a cause of impairment and a TMDL is, therefore, not necessary for this pollutant category. It is recognized that sediment loading will probably need to be addressed in some locations throughout the Soda Butte drainage for the purpose of reducing metals loading from areas disturbed by mining or other activities.

4.2 Metals Source Characterization

4.2.1 Source Inventory

Mining related disturbances are the primary source of increased metals loading above natural background conditions in the Miller Creek and Soda Butte drainage areas. These disturbances are associated with historical adits, waste rock and tailings, most of which are shown in Figure 4-1. Mine disturbances within Miller Creek have the potential to increase metal loads to both Miller and Soda Butte Creeks. Note that there are also several mine disturbances not within the Miller Creek drainage, but still within the Soda Butte drainage. The McLaren Tailings, located adjacent to Soda Butte Creek and at least partly within the Soda Butte Creek floodplain, is the most significant of these. There is a long history of site characterization and efforts to mitigate problems associated with the McLaren Tailings, most of which are summarized within the Site Evaluation Report (Pioneer, 2001a) and also by Boughton (2001). Forest, high elevation shrubland, rock, and transitional areas from recent fires cover most of the remaining drainage area (Figure 1-4).

The town of Cooke City is also located along Soda Butte Creek as well as a major highway (Highway 212). Waste disposal from Cooke City is via septic tanks. There do not appear to be significant metals sources from Cooke City or from the nearby highway such as from a historic spill event. The synoptic sample results (Boughton, 2001) indicate a lack of metals inputs from the Cooke City area, at least during low flow. Neither of the impaired water bodies or their tributaries receive point source discharges regulated by a Montana

Pollutant Discharge Elimination System permit, meaning that waste load allocations are not necessary for these water bodies.

Natural background conditions associated with acid rock drainage have been discussed as a potentially significant source of metals in the Daisy and Fisher Creek drainages (Sections 2.2.2 and 3.2.2). The lack of acid drainage conditions and lower overall metals concentrations in the Miller and Soda Butte Creek drainages, when compared to the Daisy and Fisher Creek drainages, indicate that natural background metal concentrations are probably significantly lower for Miller and Soda Butte Creeks.

4.2.2 Metals Source Analysis for Miller Creek

The majority of higher metal concentrations in Miller Creek occur during higher flow periods. At high flows, copper, iron, lead, manganese and aluminum are all significantly higher than during low flows at both SW-2 and SW-5 sample locations. The exact mechanisms driving this increased load are unknown, but it is presumably related to a combination of: the transport of metal contaminated soils eroded from mine disturbance areas, increased ground water flows or mine adit flows with corresponding increases in contaminant transport, the re-suspension of contaminated sediments associated with metals precipitates deposited during lower flows, and/or potential increases in natural background loading.

During lower flows, copper is elevated, typically at levels just below water quality standards, with an occasional value above the chronic aquatic life standard. There are also occasional high values associated with zinc and lead at the SW2 and/or SW5 monitoring sites. Review of the USGS synoptic sampling data, which will soon be available in a published report, identifies some of the small tributaries and general locations where elevated metals loads, particularly relating to copper, are entering Miller Creek during low flow conditions (12/01 discussion with Tom Cleasby, USGS). The results of the USGS synoptic study indicate that metal loading to Miller Creek during low flow was relatively small and had generally minor effects on metal concentrations in Miller Creek. Substantial differences in metal loading from mine-affected areas and areas influenced by local geology could not be readily determined. During the study, total-recoverable concentrations of copper, lead, and zinc in Miller Creek were less than the chronic aquatic-life criteria in all samples with the exception of one lead value. Further attempts can be made to link the loads to specific mine disturbances identified in Figure 4-1 once the synoptic report is published. This will not only provide an indicator of low flow sources of metals, but also provide potential links to sources of elevated loads during higher flow periods, which tend to be the flow periods of primary interest for restoration planning. Additional loading associated with erosion from mining and other disturbance areas must also be recognized as a potential source contribution during the higher flow events. Stream sediment results from the synoptic study can also provide potential links to some of the same copper sources as well as sources of cadmium, lead, and zinc.

A comparison of in-stream copper loads during various flow conditions indicates that most sources are above sample location SW-2, although some of the high flow data (Maxim, 2001a) indicate possible copper and iron sources below SW-2 when SW-2 metal loads are compared to SW5 metal loads.

4.2.3 Metals Source Analysis for Soda Butte Creek

The metals loading to Soda Butte can be divided into several potential source areas (reference Figure 4-1). These include:

1. The Miller Creek drainage,
2. The McLaren Tailings Area which includes the McLaren Mill Site,
3. Soda Butte Upstream (potential sources upstream of the McLaren Tailings Area but not within the Miller Creek drainage);
4. Woody/Republic Creek Drainage (potential sources associated with the Woody Creek and Republic Creek drainage area, often referred to as one or the other in different reports),
5. An unnamed tributary (Unnamed Creek) that enters Soda Butte Creek from the south just upstream from SBC4, and
6. Other Sources and Tributary Drainages: (Cook City, miscellaneous mine and other potential dumps in the vicinity of Cooke City; drainages associated with Sheep Creek and Wyoming Creek, and floodplain deposits to the Soda Butte Creek floodplain from past tailings dam failure and flood events).

The Unnamed Creek is completely in Wyoming, and sample location SBC4 is also in Wyoming just upstream of Yellowstone National Park (YNP) and downstream from Unnamed Creek. Meeting Montana Water Quality Standards at SBC4 is considered relevant since there are portions of Soda Butte Creek just downstream within the YNP that meander between Montana and Wyoming. The assumption is that this segment of Soda Butte Creek must satisfy both Montana and Wyoming standards. Where Montana Standards apply in Yellowstone National Park, Soda Butte Creek is classified as A-1.

The recent USGS synoptic sampling study that was performed in August 1999 (Boughton, 2001) quantifies low flow metal loading along with water quality data all along Soda Butte Creek. Appendix F is an excerpt from this report that provides a discussion on the results and conclusions from this study as well as some of the plots of metal load versus distance downstream. These plots clearly illustrate major loading sources for several metals of concern (iron, manganese, aluminum), and provide useful loading information for all of the above referenced potential source areas and all metals of concern during typical low flow conditions.

Tables 4-3 and 4-4 provide a summary of estimated total load contributions from each potential source area for each metal of concern. Appendix G is a discussion that provides the basis for these estimated load contributions. The primary data sources used for these estimates are the website database (Maxim, 2001a), the USGS synoptic report (Boughton, 2001), Soda Butte Creek copper data from Nimmo et al. (1999), and the 1999 and 2000 sample results from the USGS at their gaging station at SBC4 (USGS, 2001). Note that there is still a significant need for high flow source assessment work.

Table 4-3. Estimated Total Cumulative Load Contributions by Source Area for Soda Butte Creek in the Vicinity of SBC2 (based on total recoverable metals)

Source Area	Low Flow Estimated Cumulative Load Contributions (Percent of Total Load)	High Flow Percent Cumulative Load Contributions (Percent of Total Load)
Miller Creek	Copper: 10 - 25 % Iron: < 10 % Manganese: < 5 % Lead [1] Not Estimated Aluminum [1] Not Estimated	Copper: 50 - 90 % Iron: 35 - 60 % Manganese 50 - 75 % Lead > 50 % Aluminum Not Estimated
McLaren Tailings Area	Copper: 60 - 90 % Iron: 70 - 95 % Manganese: 80 - 95 % Lead [1] Not Estimated Aluminum [1] Not Estimated	Copper: > 5 % Iron: 20 - 40 % Manganese: 20 - 40 % Lead: ?? % Aluminum: Not Estimated
Soda Butte Upstream of McLaren Tailings Area	Copper: < 5 - 10% Iron: < 10% Manganese: < 5% Lead [1] Not Estimated Aluminum [1] Not Estimated	Copper: < 10 % Iron: 10 - 30 % Manganese: < 5 % Lead: < 5 % Aluminum: Not Estimated

Notes:
1 Lead and aluminum have not been identified as low flow problems in this section of Soda Butte Creek, most loading during low flow comes from the McLaren Tailings

Table 4-4. Estimated Total Cumulative Load Contributions by Source Area for Soda Butte Creek in the Vicinity of SBC4 (based on total recoverable metals unless otherwise noted)

Source Area	Low Flow Estimated Load Contributions (Percent of Total Load)	High Flow Estimated Load Contributions (Percent of Total Load)
Miller Creek	Copper: < 5 - 25 % Iron[1]: < 5% Manganese[1,2]: < 5% Lead[2]: Not Estimated Aluminum[1](dissolved): < 5%	Copper: ?? - 90% Iron: 5 - 15% Manganese: 15 - 30% Lead: 25 - 30% Aluminum[3](dissolved): ?? %
McLaren Tailings Area	Copper: ?? - 90 % Iron[1]: 25 - 30 % Manganese[1,2]: 80 - 85 % Lead[2]: Not Estimated Aluminum[1] (dissolved): 5% - 10%	Copper: ?? % Iron: 5 - 10 % Manganese: < 5 % Lead: ?? % Aluminum[3](dissolved): < 5%
Soda Butte Upstream of McLaren Tailings Area	Copper: < 5 - 10 % Iron[1]: < 5% Manganese[1,2]: < 5% Lead[2]: Not Estimated Aluminum[1](dissolved): < 5%	Copper: < 5 % Iron: < 5 - 15 % Manganese: < 5 % Lead: < 5 % Aluminum[3](dissolved): < 5 %
Woody/Republic Creek	Copper: ?? % Iron[1]: 35 - 40 % Manganese[1,2]: 9 % Lead[2]: Not Estimated Aluminum[1](dissolved): 60 - 70%	Copper: ?? % Iron: ?? % Manganese: ?? % Lead: ?? % Aluminum[3](dissolved): ?? %
Unnamed Creek	Copper: ?? % Iron[1]: 30 - 35 % Manganese[1,2]: 5 % Lead[2]: Not Estimated Aluminum[1](dissolved): 20 - 30 %	Copper: ?? % Iron: ?? % Manganese: ?? % Lead: ?? % Aluminum[3](dissolved): ?? %
Other Sources (Cook City, hillside sources, in-stream and floodplain, other tributaries)	Copper: ?? % Iron[1]: < 5% Manganese[1,2]: < 5% Lead[2]: Not Estimated Aluminum[1](dissolved): 5 - 10%	Copper: ?? % Iron: ?? % Manganese: ?? % Lead: ?? % Aluminum[3](dissolved): ?? %

Notes

1 Low flow values for iron, manganese, and aluminum are based primarily on cumulative inflow results from the Appendix H reference (Boughton, 2001), with adjustments to incorporate potential ground water loading associated with the major sources

2 Lead and manganese are generally not considered a low flow beneficial use concern in this section of Soda Butte Creek; manganese load estimates are shown due to good data availability

??% - lacking data to make estimates

4.3 Restoration Targets, TMDLs, and Load Allocations

4.3.1 Metals Restoration Targets

Table 4-5 provides target values for metals based on the applicable standards identified in Tables 4-1 and 4-2. Most metals targets are based on the applicable numeric water quality standard with hardness modifications for copper, cadmium, zinc, and lead. Because it is unknown what the actual hardness value will be under restoration conditions, the Table 4-5 values for copper, cadmium, zinc, and lead represent estimated values at high and low flow conditions as identified in Tables 4-1 and 4-2. The actual targets for these four metals are the water quality standard with applicable hardness adjustments based on actual in-stream hardness values at the time of measurement. Appendix A of this document provides an example of the hardness adjustment equation for chronic aquatic life support standards (reference Montana Water Quality Standards WQB-7 for more information and for the similar equation used for acute aquatic life computations).

All metal targets are based on total recoverable concentrations unless otherwise noted. For aluminum, iron, and manganese, the standard and any applicable targets are not a function of hardness. Where there are multiple numeric standards for protecting different beneficial uses, the lowest value is used to ensure protection of all beneficial uses. If the chronic and acute aquatic life targets are different than each other, then the primary target for TMDL development and restoration planning becomes the chronic aquatic life support standard to provide some margin of safety since the chronic standard is normally based on a 96-hour average

The numeric targets cannot be exceeded at any time. Monitoring locations SW2 or SW5 in Miller Creek and monitoring locations SBC-2, SBSW-102, and SBC-4 in Soda Butte Creek should be used for determining compliance with targets. To meet the numeric targets, there must be at least three consecutive years where target values are met during late winter/early spring low flow, late summer/early fall low flow, and peak or near peak late spring/early summer runoff. All other targets further discussed below need only be measured and confirmed once in conjunction with meeting numeric levels, using the above referenced monitoring locations unless otherwise noted.

Iron has an additional target for Soda Butte Creek of no visible streambed deposits resulting from human caused conditions. This target is applied at low flow conditions just below the McLaren Tailings Area where the problem has been noted. The purpose of this target is to protect the beneficial uses of aquatic life as well as aesthetic values of the stream.

Copper has an additional target based on stream sediment toxicity in both Miller Creek and Soda Butte Creek, and lead has a similar such target for stream sediments in Miller Creek. Sediment toxicity must be measured during low flow autumn or early spring conditions to capture impacts from runoff and associated metals depositions.

As an additional measure of overall beneficial use attainment, a target is set for macroinvertebrate and periphyton communities being at 75% or greater in comparison to reference stream conditions using established protocols for evaluating metals impairment conditions.

4.3.2 Metals TMDLs

Table 4-6 through 4-8 provide example TMDLs for metals based on values from different flow periods which represent water quality variations for Miller Creek (SW5) and Soda Butte Creek **(**SBC2 and at or in the vicinity of SBC4). These TMDLs are calculated as examples of typical lower and higher flow conditions, since the actual TMDL will always be dependent on specific flow conditions as defined by the following equation (also reference Appendix A of this document):

Total Maximum Load in lb/day
(X ug/l) (Y ft^3/sec) (0.00534) = (X)(Y)(0.00534) lb/day

where:
X = the applicable water quality numeric standard (target) in ug/l with hardness adjustments
where applicable (see above discussion on targets);
Y = streamflow in cubic feet per second;
(0.00534) = conversion factor

The above equation addresses all seasonal flow variations, and the examples in Tables 4-6 through 4-8 further evaluate seasonality by addressing differences associated with lower and higher flow conditions of hardness and pollutant levels.

Some additional notes concerning the TMDLs in Tables 4.6 through 4.8 are discussed below:

For iron, the TMDL based on the 300 ug/l drinking water/domestic use support condition will satisfy the additional target of no visible streambed deposits associated with fine materials from human causes.

Meeting the copper TMDLs in Miller Creek and Soda Butte Creek is expected to satisfy the targets associated with sediment toxicity for both water bodies. Likewise, meeting the lead TMDLs in Miller Creek is expected to satisfy the sediment toxicity target for lead in this water body. It is assumed that as metal loading is reduced to TMDL levels, the existing fine sediments with metals contamination will likely flush through the system at high flows as they have probably been doing over the years, the difference being that they will start being replaced by fewer and cleaner fine sediment deposits.

Meeting all of the metals targets is expected to satisfy the target associated with macroinvertebrate and periphyton communities being at 75% or greater in comparison to a reference stream

Tables 4-6 through 4-8 also provide estimates of the percent total load reduction needed to meet the daily load associated with the Table 4-5 targets. These calculations can be made based on existing concentrations and target concentrations. Since low flow conditions in

Miller Creek tend to indicate fairly good support for aquatic life, low flow percent reductions were not calculated for Table 4-6. Also, a lack of high flow data at SBC2 made it difficult to calculate average high flow percent reduction requirements for this location.

The data used for Tables 4-6 through 4-8 were obtained from the Maxim database and several of the references discussed in Section 4.1.1. Typically only one representative high flow and one representative low flow set of data per year, per location, where available, were used. Additional data were used for 1999 and 2000 high flow events in Soda Butte Creek at SBC4 because of the variability in the data and the importance of the information in regards to meeting Montana's water quality standards. Tables D-6 and D-7 in Appendix D provide a summary of the data used for Tables 4-6 through 4-8.

For Miller Creek high flow conditions, copper requires the greatest average percent reduction (93%) in total load, followed closely by lead (86%). High flow average load reductions for iron, cadmium, and manganese range from 42% to 56%. Unfortunately, there is a limited amount of high flow data that seems to represent the apparent peak runoff conditions used for these calculations. The copper and lead values are high primarily due to data from two very high flow events. As flows decrease, metals values are lower (Table D-6), indicating percent load reduction requirements would be lower to satisfy targets during much of the year. Nevertheless, the targets apply throughout the year, and impacts to beneficial uses during typical peak flows must be considered.

Metal concentrations upstream at SW-2, particularly copper, are also very high and comparable to those measured at SW-5 on the same very high flow days. Other flow events are also consistent, with copper levels sometimes slightly higher at SW2 than SW5 during low flows. The low flow concentrations at SW2 indicate the need for an approximate 10% to 20% average reduction in copper loading in order to consistently remain below the aquatic life standard associated with chronic conditions.

For Soda Butte Creek at SBC2, the average percent reductions for iron and manganese at low flow conditions are 82% and 38% respectively. A low flow copper percent reduction is difficult to calculate based on a lack of detections above standards from most data sources. There is also a lack of high flow data at this location to determine average concentrations and average percent reductions for most metals. Dissolved copper results from Nimmo et al. (1999) indicate that copper loads may need to be reduced by as much as 25% or more during low flows and 50% or more during high flows to ensure that water quality levels remain below applicable standards every year at this location.

For Soda Butte Creek at SBC4, the average percent reduction for iron at low flow fall conditions is 13%. Most other metals only had limited or no detections above water quality standards during low flows. Data from Nimmo et al. again indicates a need for some reduction in copper loading during some low flow periods, possibly as much as 25% or more. High flow events indicate fairly large average percent reductions needed, at least during some of the highest flow events, to consistently meet water quality standards: 57% for copper, 88% for iron, 36% for manganese, and 92% for lead (based on data from USGS, 2001 and Maxim, 2001a).

Table 4-5. Metals Water Quality Restoration Targets for Miller Creek and Soda Butte Creek

Stream(s)	Pollutant	Target(s)	Limiting Beneficial Use
Miller Creek & Soda Butte Creek	Copper[1]	4.7 ug/l (high flow) 7.3 ug/l (low flow) sediment concentrations at non-toxic levels	Aquatic Life (chronic) Aquatic Life (chronic) Aquatic Life
Miller Creek	Cadmium[1]	0.15 ug/l (high flow) 0.22 ug/l (low flow)	Aquatic Life (chronic) Aquatic Life (chronic)
Miller Creek & Soda Butte Creek	Lead[1]	1.2 ug/l (high flow) 2.2 ug/l (low flow) sediment concentrations at non-toxic levels (Miller Creek)	Aquatic Life (chronic) Aquatic Life (chronic) Aquatic Life
Miller Creek	Zinc[1]	61 ug/l (high flow) 94 ug/l (low flow)	Aquatic Life (acute & chronic) Aquatic Life (acute & chronic)
Miller Creek & Soda Butte Creek	Iron	1000 ug/l (both streams) 300 ug/l (both streams) no visible streambed deposits associated with controllable human causes below McLaren Tailings in Soda Butte Creek	Aquatic Life Drinking Water (domestic use) Aquatic Life/Aesthetics
Miller Creek & Soda Butte Creek	Manganese	50 ug/l	Drinking Water (domestic use)
Miller Creek	Aluminum	87 ug/l (dissolved)	Aquatic Life
Miller Creek & Soda Butte Creek	Metals	Macroinvertebrate and periphyton communities at 75% or greater of reference stream conditions	Aquatic Life

Notes:
1. All targets for this pollutant are estimated based on predicted hardness values after completion of restoration activities, actual values will be determined by hardness as defined in Appendix A

Table 4-6. Miller Creek TMDL and Load Reduction Examples for Metals at Typical High and Low Flow Conditions at Sample Location SW5

Pollutant	Target (ug/l)	Mean Low Flow (0.5 cfs) TMDL (lb/day)	Mean High Flow (60 cfs) TMDL (lb/day)	% Total Load Reduction Needed to Meet TMDLs and Targets
Copper	7.3 (low flow) 4.7 (high flow)	0.02	1.5	-- % (low flow) [1]; 93% (high flow)
Cadmium	0.22 (low flow) 0.15 (high flow)	0.0006	0.048	-- % (low flow) [1]; 46% (high flow)
Lead	2.2 (low flow) 1.2 (high flow)	0.006	0.38	-- % (low flow)[1]; 86% (high flow)
Zinc	94 (low flow) 61 (high flow)	0.25	20	-- % (low flow) [1]; -- % (high flow) [1]
Iron	300 (all flows)	0.80	96	-- % (low flow) [1]; 87% (high flow)
Manganese	50 (all flows)	0.13	16	-- % (low flow) [1]; 42% (high flow)
Aluminum	87 (all flows; dissolved aluminum only)	0.23	28	-- % (low flow) [1]; -- % (high flow) [2]

Notes:

1 There are either no values or a limited number of values at high enough levels to calculate a percent reduction

2 There is a lack of dissolved aluminum data at high flows to determine whether or not there is a need for a reduction in load

Table 4-7. Soda Butte Creek TMDL and Load Reduction Examples for Metals at Typical High and Low Flow Conditions At or Near Sample Location SBC-2

Metal/Pollutant	Target (ug/l)	Mean Low Flow (0.8 cfs) TMDL (lb/day)	Mean High Flow (40 cfs) TMDL (lb/day)	% Total Load Reduction Needed to Meet TMDLs and Targets
Copper	7.3 (low flow) 4.7 (high flow)	0.03	1.0	-- %(low flow) [1] -- %(high flow) [2]
Iron	300 (all flows)	1.3	64	82 % (low flow) -- % (high flow) [2]
Manganese	50 (all flows)	0.21	11	38 % (low flow) -- % (high flow)[2]
Lead	2.2 (low flow) 1.2 (high flow)	0.009	0.26	-- % (low flow)[1] -- % (high flow) [3]

Notes:
1 A limited number of values above levels of concern makes it difficult to calculate an average % reduction
2 The lack of high flow data makes it difficult to determine a percent reduction
3 A lack of detections at low flow implies that lead may be only a higher flow concern

Table 4-8. Soda Butte Creek TMDL and Load Reduction Examples for Metals at Typical High and Low Flow Conditions At or Near Sample Location SBC-4

Metal/Pollutant	Target (ug/l)	Mean Low Flow (12 cfs) TMDL (lb/day)	Mean High Flow (337 cfs) TMDL (lb/day)	% Total Load Reduction Needed to Meet TMDLs and Targets
Copper	7.3 (low flow) 4.7 (high flow)	0.47	8.4	-- %(low flow) [1] 57 %(high flow)
Iron	300 (all flows)	19	540	13 % (low flow) 88 % (high flow)
Manganese	50 (all flows)	3.2	90	-- % (low flow) [2] 36 % (high flow)
Lead	2.2 (low flow) 1.2 (high flow)	0.14	2.2	-- % (low flow)[3] 92 % (high flow)

Notes:
1 A limited number of values above levels of concern makes it difficult to calculate an average % reduction
2 A lack of detections at low flow implies that manganese is only a higher flow concern at this location
3 A lack of detections at low flow implies that lead may be only a higher flow concern

4.3.3 Load Allocations

The strategy for allocating loads varies between Miller Creek and Soda Butte Creek. The allocations are discussed separately below.

4.3.3.1 Performance Based Load Allocation for Miller Creek

A performance based allocation approach is used for metals load allocations for Miller Creek. This approach relies on detailed plans and practices that will be developed and applied to all significant mining sources on District Property that are impacting Miller Creek. The *Petition Report* (Stanley, 1999) and the *Final Overall Project Work Plan for the New World Mining District Response and Restoration Project* (Maxim, 1999) provide details concerning the overall restoration strategy for District and some non-District property within the Cooke City Planning Area. The *Petition Report* includes schedules and detailed site descriptions and anticipated restoration activities. The *Final Work Plan* further describes the process whereby potential pollutant sources (e.g. mine dumps, adits, etc.) are evaluated and restoration approaches are analyzed in detail and undergo stakeholder review and comment prior to selection of a final restoration approach for each location of concern. The information is then documented in an annual work plan, which may address one or more locations where restoration is planned over the coming year. This process continues every year with the goal of achieving cleanup by 2014 as required by the Temporary Water Quality Standards. *The New World Mining District Response and Restoration Project: Project Summary, 2001* (Maxim, 2001b) also describes the restoration planning and implementation process for the District.

Overall, a total of 18 source areas have been identified in the District. The source areas that involve Miller Creek including a summary of the general activities that are planned as well as some potential restoration actions, are discussed below (reference Figure 4-1).

•District Property	Includes all property or interest relinquished by CBMI. Activities will include: surveying the District for additional sources; characterize chemistry, thickness, and quantity of sources (waste rock dumps or tailings) through borehole drilling; identify and investigate potential waste rock disposal sites; identify potential borrow sources; survey cultural resources; and monitor surface and ground water resources. Restoration activities can include activities such as removal to the repository site and/or drainage control.
•Miller Creek	Comprises the Miller Creek drainage basin including the southwest flank of Henderson Mountain, the southeast flank of Crown Butte and the northeast flanks of Miller Mountain. Disturbances and mine waste in this source area will be characterized to determine necessary removal actions. This also includes efforts to reduce adit inflows or rehabilitate adits as necessary, particularly the adit in the area of the Black Warrior mine.

•Alice E Mine and Mill Site	This site is not on District Property. It includes the mine, mill, and waste rock material on the south side of Henderson Mountain. Assessment of sources present at this site will be done along with assessment of District Property wastes. Cleanup work on this source area will be deferred until cleanup of District Property is complete.
•Road Systems	Roads within or accessing District Property will be evaluated to determine which roads should be closed and which roads will be used during removal actions. In addition, best management practices typically associated with drainage improvements and other erosion controls will likely be pursued on roads and trails where closure is not consistent with overall forest recreational goals.
•Wetland, Stream Bank	Includes contaminated material deposited along stream thalwegs and transported sources and bog material with elevated metal concentrations. Disturbances in this source area will be characterized to determine necessary removal actions.

Figure 4-1 shows the locations of most or all of the mine disturbances in the Miller Creek drainage. These mine disturbances are all addressed under one or more of the above categories. Even though sediment is not identified as a separate pollutant for TMDL development, erosion protection activities associated the Road Systems source area discussed above may provide important reductions in metal loading to Miller Creek. Important areas to address erosion protection would be in areas of mine disturbances and where roads intersect mined or heavily mineralized areas. Figure 4-2 shows the fairly significant road system that exists in the Miller Creek drainage.

Some of the potential sources of metals to Miller Creek include erosion from roads and other disturbed areas and sources located on non-District Property. The *Consent Decree and Settlement Agreement* (United States District Court for the District of Montana Billings Division, 1998) provides further restoration guidance for all sources in the Daisy, Fisher, and Miller Creek drainages as well as sources within the whole New World Mining District. Per the Natural Resources Working Group for the New World Mining District Response and Restoration Project, there are two categories of work that can be done (Natural Resources Working Group Meeting Summary, June 19, 2002). These are:

- Category A - hazardous substances (i.e. mine waste) that are on District Property and non-hazardous substances (e.g. principally sediment from roads) on District Property. Work can be done prior to the receipt of the Notice of Completion from the United States Government.

- Category B – after receipt of the Notice of Completion, work can address other hazardous and non-hazardous sources on non-District Property.

It is assumed that all significant metals and pH related sources, other than natural background sources, to Miller Creek are "Category A" or "Category B" type sources that will be addressed as part of the New World Restoration efforts. The "Category A" sources, which are located on District Property (reference Figures 4-1 and 4-2), will be addressed as part of the consent decree requirements for a notice of completion. Any significant "Category B" sources located on either private or Forest Service lands will be addressed within the budget constraints of the New World restoration project after issuance of the notice of completion. If there is not adequate budget, then a load will be allocated to each significant source to reflect loading conditions needed to ensure that water quality targets would be met once each new allocation is satisfied.

It is assumed that all New World restoration activities will be implemented in a manner that represents all reasonable land, soil, and water conservation practices and therefore will satisfy the intent of Montana's Water Quality Standards for metals. This includes appropriate implementation monitoring and maintenance of restoration efforts to ensure success.

As previously discussed, once metals loading approaches TMDL levels the existing fine sediments with metals contamination will likely flush through the system at high flows as they have probably been doing over the years, the difference being that they will start being replaced by fewer and cleaner fine sediment deposits. Note that the restoration work for the "Wetland, Stream Bank" source area is intended to verify this assumption and address significantly high levels of metals contaminants in stream sediments and floodplain material if they did not flush through the system as anticipated.

Section 5.0 in this document summarizes some additional components of the overall restoration strategy for Miller Creek.

4.3.3.2 Load Allocations for Soda Butte Creek

As discussed in Appendix A, the TMDL can be expressed as the sum of the load allocations plus the sum of the waste load allocations plus a margin of safety. There is not a need for waste load allocations and the margin of safety is addressed via the use of chronic standards under all conditions, via significant monitoring to ensure that targets are obtained, and other criteria and assumptions summarized in Table E-1.

To help ensure protection of beneficial uses in Soda Butte Creek and appropriately address the different sources and flow conditions in this water body, load allocations are developed for the three monitoring locations of SBC2, SBSW102, and SBC4. Load allocations are identified for the following source areas:

1. The Miller Creek drainage,
2. The McLaren Tailings Area which includes the McLaren Mill Site,
3. Sheep Creek Drainage,
4. Wyoming Creek Drainage,
5. Woody Creek Drainage (includes Republic Creek Drainage),
6. The Unnamed Creek Drainage that enters Soda Butte Creek from the south just upstream from SBC4, and

7. Remaining Sources (includes Cook City, miscellaneous mine disturbance locations that are not addressed under any of the other above categories, and floodplain deposits from past tailings dam failure and flood events).

Note that the source areas are organized a little differently from the way they were organized for source assessment purposes. Some of the individual drainages, such as Sheep Creek and Wyoming Creek, are addressed separately since load allocations need to also satisfy water quality standards for these streams. Sources of metals in the upper portion of Soda Butte Creek above the McLaren Tailings Area are grouped within Remaining Sources since this section of stream is already satisfying water quality standards. Any load reductions in this upper section of the drainage can then be counted toward accomplishing overall load reduction requirements for downstream portions of Soda Butte Creek.

The TMDL equations for the three locations of concern, using the TMDL loading capacity equation from Page A-1 in Appendix A, are identified below using copper as an example.

Copper TMDL (SBC2) = **Copper Loading Capacity at SBC2** = (Miller Creek Copper Load Allocations) + (McLaren Tailings Area Copper Load Allocations) + (Copper Load Allocations to Remaining Sources Upstream of SBC2).

Copper TMDL (SBSW102) = **Copper Loading Capacity at SBSW102** = (Copper Loading Capacity at SBC2) + (Woody Creek Copper Load Allocations) + (Copper Load Allocations to Remaining Sources Between SBSW102 and SBC2)

Copper TMDL (SBC4) = **Copper Loading Capacity at SBC4** = (Copper Loading Capacity at SBSW102) + (Sheep Creek Copper Load Allocations) + (Wyoming Creek Copper Load Allocations) (Unnamed Creek Copper Load Allocations) + (Copper Load Allocations to Remaining Sources Between SBC4 and SBSW102)

The above equations apply to each of the other metals of concern at each location. For example, there are five equations at SBC2 to address TMDLs for copper, iron, manganese, lead and aluminum. Water quality standards and WQRP targets can be satisfied by ensuring that the load allocations are equal to, or remain below, the maximum daily load at the location of interest for each metal of interest. The load allocations must be satisfied for both high and low flow conditions to address all seasonal variations and all flow conditions between high and low flows.

Below is a discussion of the source area load allocations followed by a discussion on the estimated load reductions needed by source area for each metal of concern.

4.3.3.2.1 Load Allocations by Source Area

4.3.3.2.1.1 Miller Creek

Miller Creek load allocations are defined in Section 4.3.3.1. These allocations rely on load reductions from pursuing a performance-based approach applied to mining disturbances in the drainage to meet Miller Creek targets and satisfy the Miller Creek TMDLs. Since

Miller Creek and Soda Butte Creek have the same metals targets, the Miller Creek load allocation approach will sufficiently protect Soda Butte Creek.

4.3.3.2.1.2 Woody Creek, Wyoming Creek, and Sheep Creek

For Woody Creek (includes Republic Creek), Sheep Creek, and Wyoming Creek, load allocations are based on TMDLs applied at the mouth of each stream. The TMDLs are based on the same targets as those applied to Soda Butte Creek since these streams are also classified as B-1 in Montana Water Quality Standards (Section 17.30.611). This will ensure that water entering Soda Butte Creek from these major tributaries is at or below the concentration associated with water quality standards and targets for Soda Butte Creek. These TMDLs are determined by the equation presented in Section 4.3.2, using the numeric targets identified for Soda Butte Creek in Table 4-5 multiplied by the flow at any given time. Of course, the water quality standards for copper and lead are also hardness dependent as defined by the equations in Appendix A and WQB-7.

The load allocations to satisfy the TMDL for each metal in each of the three tributaries are the combination of natural background sources and metals loading from mine disturbances located within the tributary drainage. Because natural background sources do not represent a controllable load reduction, any load reductions needed to satisfy each metal load allocation must come from mining related sources in the tributary, assuming such sources exist and can be identified and addressed via reasonable land, soil and water conservation practices. It appears as though some of the tributaries are already meeting some of the metal load allocations under certain flow conditions (Boughton, 2001).

4.3.3.2.1.3 McLaren Tailings Area

The McLaren Tailings Area load allocations for metals are based on meeting concentrations that will avoid toxic conditions and ensure compliance with targets. Similar to the tributary load allocation approach, this can be addressed by ensuring that ground water and seep inflows meet stream target concentrations and therefore satisfy the need to avoid toxic conditions associated with copper, lead and iron. This approach is also necessary to avoid iron precipitates and associated streambed deposits and to avoid a situation where localized toxic conditions limit fish passage in the area. In addition, erosion will need to be controlled to significantly reduce metals loading from this pathway.

The manganese target is associated with drinking water/domestic use and is not associated with toxic conditions. The load allocation for manganese can be based on the goal of keeping the manganese load low enough to ensure the target is met at SBC2, meaning that in-stream mixing can be considered

The allowable load to satisfy the above conditions is allocated to the McLaren Tailings and associated mine disturbances in the immediate vicinity across from the tailings. Any natural background levels of metals in ground water in this area are also part of this allocation, although such levels are probably very low in comparison to other highly mineralized areas in the Cooke City TMDL Planning Area.

Given the high iron loading from the McLaren Tailings Area and the significant threat associated with a tailings dam failure, it is assumed that restoration requirements will result in the removal of these threats and will need to achieve at least a 99% reduction in total load for iron. This will then satisfy the iron load allocation. This 99% reduction is therefore used to help estimate average total load allocation and reductions needs for other source areas throughout Soda Butte Creek. Since this restoration approach will likely have similar positive impacts toward reducing loads from the other metals associated with the McLaren Tailings Area, then a 99% load reduction from the McLaren Tailings Area is also assumed for copper, manganese, lead, aluminum and any other metals of concern.

4.3.3.2.1.4 Unnamed Creek

This stream is entirely in Wyoming and Montana Standards would not specifically apply to this stream. Metal loads and related load allocation must be low enough to meet targets at SBC4 to protect the downstream section of Soda Butte Creek that meanders back and forth between Montana and Wyoming.

4.3.3.2.1.5 Remaining Sources

Remaining Sources include inflows and runoff from the Cooke City area and minor tributaries and inflows all along Soda Butte Creek. Some of the specific mine disturbance areas that fall into this overall category include, but are not limited to, the Soda Butte Dumps, the Alice E. Mill Site, and tailings/pollutant deposits in the floodplain from past floods. Allocated metals loading or necessary load reductions associated with this source area are based on conditions needed to ensure that standards and targets are satisfied all along Soda Butte Creek, with focus on monitoring locations SBC2, SBSW102, and SBC4. The individual metals loads are allocated to natural background conditions, potential Cooke City sources, floodplain sources, and mining disturbances not already addressed under one of the other sources discussed above. At this time, there is insufficient data to quantify the existing loads from these Remaining Sources and to identify required load reductions. If there is a need for load reduction(s), then the load reductions would likely apply to mining sources and other source types. This load reduction would be equal to the reduction needed to meet water quality standards in Soda Butte Creek once all other source areas are satisfying their specific TMDL and load allocation requirements discussed above.

Identifying such overall load reductions from this source area can be data intensive and could take a number of monitoring seasons to quantify. To help ensure that Soda Butte Creek targets are met, mine disturbances that are part of this Remaining Sources should be individually analyzed for their potential to contribute significant loads to nearby surface or ground water via seeps or direct runoff or any other pathway. If the significant potential for metals loading is identified for a mine disturbance, then a load allocation will be applied to this source in a manner similar to the above method for the McLaren Tailings, taking into consideration the potential for erosion related transport of metal loads.

4.3.3.2.2 Estimates of Load Reduction Needs by Source Area

It is helpful to estimate the average total load reductions, by source area, needed to meet Soda Butte Creek targets and TMDL conditions during low and high flow conditions. This average total load reduction is the existing average load minus the load allocation. This information can then be used to assist with restoration planning and help identify areas where additional data is needed to further characterize metals sources and source area contributions. The goal is to help ensure that the anticipated load reductions from planned restoration activities for all source areas are consistent with the load reductions needed to satisfy Soda Butte Creek targets and TMDLs. For the section of Soda Butte Creek between the McLaren Tailings Area and Woody/Republic Creek, these load reductions can be estimated to some extent by comparing Table 4-7 metals load reduction requirements to the Table 4-3 estimated percent cumulative loads by source area. For the section of Soda Butte Creek below Woody/Republic Creek, they can be estimated to some extent by comparing the Table 4-8 percent metal load reduction requirements to the Table 4-4 estimated percent cumulative loads by source area.

Tables 4-9 and 4-10 are used to summarize load reduction information and needs for Soda Butte Creek above the confluence with Woody/Republic Creek at SBC2 and just above Yellowstone National Park at SBC4. The first column in each table identifies the metal of concern. The second column lists the source areas, split for low and high flow conditions, for the location of concern. Note there are fewer source areas at SBC2 (Table 4-9) since it is the upstream location. The third column identifies the anticipated load reduction once the load allocation is satisfied. Values are only provided where data is available to make an estimate. Not only is this number provided for each source area/metal combination at high and low flow conditions, the available numbers are also combined to provide an overall estimated average total load reduction for low and high flow conditions. The fourth column is an estimated average reduction in total daily load needed to satisfy the TMDLs and targets conditions for each metal at low and high flow conditions. The flow related number in the fourth column can then be compared to the average flow related number in the third column to help direct restoration planning, including identification of source areas that need additional monitoring to evaluate load reduction potential. Each fourth column load reduction estimate includes a note in parentheses concerning restoration and data needs. For example, if the fourth column load reduction needs are significantly higher than the third column estimated source area reductions, then there is a probable need to identify other source areas where loads can be reduced.

In making these comparisons in Table 4-9, it appears as though efforts to address Miller Creek restoration and an anticipated 99% load reduction for the McLaren Tailings Area will satisfy the load reductions needed for all TMDLs and targets for the upper section of Soda Butte Creek. This conclusion is not surprising since the source analysis (Section 4.2.3) had previously failed to identify any other significant source areas of concern besides Miller Creek and the McLaren Tailings Area.

For Table 4-10, the same total load reductions would still apply for the Miller Creek and the McLaren Tailings source areas, but their overall percent contribution in load reduction at SBC4 would tend to be lower for most metals depending upon the measured concentrations at SBC4. The fourth column summary notes in Table 4-10 indicate that efforts to address restoration needs in Miller Creek and at the McLaren Tailings Area could very well address all of the Soda Butte Creek load reductions needed for both copper and manganese at low flow and maybe even the copper reductions needed at high flow. It appears that many of the other source areas will need to have load reductions pursued in order to meet water quality TMDLs and targets for manganese and lead at high flows, iron at low and high flows, and aluminum during low flows. The extent that many of these other source areas contribute loads is unknown at this time, especially at higher flow conditions. Additional study is needed to characterize these specific source areas and their flow related load contributions. This study needs to also focus on potential individual sources of increased loading including an understanding of natural background loads given the potential for elevated background loads in some of these mineralized drainage areas with high natural erosion and sediment transport as discussed in Section 4.1.2.

Table 4-9. Estimated Total Load Reduction by Source Area and Comparisons to Estimated Load Reductions Needed to Meet Targets for Soda Butte Creek at SBC2

Metal	Source Area and Flow Conditions	Estimated Reduction in Total Daily Load to Soda Butte Creek at SBC2 (Percent of Total Load)[1]	Estimated Average Reduction in Total Daily Load Needed to Satisfy TMDLs and Targets at SBC2 (Percent of Total Load)
Copper	Miller Creek Low Flow: McLaren Tailings Low Flow: Miller Creek High Flow: McLaren Tailings High Flow:	2 - 5% 59 - 89% Average of Total Low Flow Range: 78% 46 - 84% >5% Average of Total High Flow Range:>70%	Low Flow: 50% (Miller Creek and McLaren Tailings Restoration work could satisfy all copper restoration needs for SBC2) High Flow: 75% (Miller Creek and McLaren Tailings Restoration work could satisfy all copper restoration needs for SBC2)
Iron	Miller Creek Low Flow: McLaren Tailings Low Flow: Miller Creek High Flow: McLaren Tailings High Flow:	0% 69 - 94% Average of Total Low Flow Range: 82% 30 - 52% 20 - 40% Average of Total High Flow Range: 71%	Low Flow: 82% (Miller Creek and McLaren Tailings Restoration work could satisfy all iron restoration needs for SBC2) High Flow: Data not available, but the load reductions from Miller Cr. and the McLaren Tailings Area could satisfy the TMDL and targets at SBC2
Manganese	Miller Creek Low Flow: McLaren Tailings Low Flow: Miller Creek High Flow: McLaren Tailings High Flow:	0% 79 - 94% Average of Total Low Flow Range: 86% 21 – 32% 19 – 38% Average of Total High Flow Range: 55%	Low Flow: 38% (Miller Creek and McLaren Tailings Restoration work could satisfy all manganese restoration needs for SBC2) High Flow: Data not available, but the load reductions from Miller Cr. and the McLaren Tailings Area could satisfy the TMDL and targets at SBC2
Lead	Miller Creek Low Flow: McLaren Tailings Low Flow: Miller Creek High Flow: McLaren Tailings High Flow:	0% Probably >50% Average of Total Low Flow Range: >50% 43 % * 48 % * Average of Total High Flow Range: 91% * based on assumption that 50% of the load comes from each source area	Low Flow: 25% to ensure remain below standards (Miller Creek and McLaren Tailings Restoration work could satisfy all lead restoration needs for SBC2) High Flow: 86% using Miller Creek data (Miller Creek and McLaren Tailings Restoration work could satisfy all lead restoration needs for SBC2)
Aluminum	No allocations for aluminum due to lack of data to make impairment determination; load reductions associated with other metals will likely reduce dissolved aluminum below levels of concern if it is found to be a problem	Significant aluminum load reductions will be accomplished per the above reductions	Reductions as Needed to Remain Below Standards (Miller Creek and McLaren Tailings Restoration work could satisfy any aluminum restoration needs for SBC2)

Notes:
1 This is the estimated reduction necessary to meet the load allocation for each metal of concern under low and high flows

??% - lacking data to make estimates

Table 4-10. Estimated Total Load Reduction by Source Area and Comparisons to Estimated Load Reductions Needed to Meet Targets for Soda Butte Creek at SBC4 (page 1 of 2)

Metal	Source Area and Flow Conditions	Estimated Reduction in Total Daily Load to Soda Butte Creek at SBC4 (Percent of Total Load) [1]	Estimated Average Reduction in Total Daily Load Needed to Satisfy TMDLs and Targets at SBC4 (Percent of Total Load)
Copper	Miller Creek Low Flow: McLaren Tailings Low Flow: All Other Source Areas (individual and cumulative source area contributions not yet determined):	<1 - 5% ?? - 89% ??% Average of Total Low Flow Range: >45%	Low Flow: 25% or more (possibly addressed via McLaren Tailings cleanup)
	Miller Creek High Flow: McLaren Tailings High Flow: All Other Source Areas (individual and cumulative source area contributions not yet determined):	?? - 84% ??% ??% Average of Total High Flow Range: >42%	High Flow: 57% (possibly addressed via Miller Creek and McLaren Tailings Area restoration efforts, needs confirmation)
Iron [2]	Miller Creek Low Flow: McLaren Tailings Low Flow: Woody Creek Low Flow: Wyoming Creek Low Flow: Sheep Cr: Unnamed Cr: Remaining Sources:	<5% 25 - 30% 23 - 26% <5% <5% ?? - 28% <5% Average of Total Low Flow Range: >66%	Low Flow: up to 50% (may need additional load reductions in addition to Miller Cr. and McLaren Tailings Area restoration work)
	Miller Creek High Flow: McLaren Tailings High Flow: All Other Source Areas (individual and cumulative source area contributions not yet determined):	<5 - 13% 5 - 10 % ??% Average of Total High Flow Range: ??%	High Flow: 88% (significant reductions needed from tributaries below Miller Creek and/or other remaining sources)
Manganese	Miller Creek Low Flow: McLaren Tailings Low Flow: All Other Source Areas (individual and cumulative source area contributions not yet determined):	<5 % 79 - 84% ??% Average of Total Low Flow Range: >82%	Low Flow: Close to 0% (No additional load reductions needed besides McLaren Tailings reductions)
	Miller Creek High Flow: McLaren Tailings High Flow: All Other Source Areas (individual and cumulative source area contributions not yet determined):	6 - 13 % <5 % ??% Average of Total High Flow Range: >10%	High Flow: 36% (significant reductions likely needed from tributaries below Miller Creek and/or other remaining sources)

Table 4-10: Estimated Total Load Reduction by Source Area and Comparisons to Estimated Load Reductions Needed to Meet Targets for Soda Butte Creek at SBC4 (page 2 of 2)

Metal	Source Area and Flow Conditions	Estimated Reduction in Total Daily Load to Soda Butte Creek at SBC4 (Percent of Total Load) [1]	Estimated Average Reduction in Total Daily Load Needed to Satisfy TMDLs and Targets at SBC4 (Percent of Total Load)
Lead	Miller Creek Low Flow: McLaren Tailings Low Flow: All Other Source Areas (individual and cumulative source area contributions not yet determined):	0% possibly > 50 % ??% Average of Total Low Flow Range: >50%(?)	Low Flow: Lead may not be a low flow concern below Woody Creek, McLaren Tailings Area reductions will likely address any potential concerns
	Miller Creek High Flow: McLaren Tailings High Flow: All Other Source Areas (individual and cumulative source area contributions not yet determined):	22 - 26% ?? % ??% Average of Total High Flow Range: >24%	High Flow: up to 92% (significant reductions likely needed from tributaries below Miller Creek and/or other remaining sources)
Aluminum	Woody Creek Low Flow: Other Source Reduction Needs Unknown	> 45 %	At this time, dissolved aluminum has only been identified as a problem in Soda Butte Creek just below Woody/Republic Creek confluence. The identified load reduction may address this situation, but further verification is needed.

Notes:

1 This is the estimated reduction necessary to meet the load allocation for each metal of concern under low and high flows

2 Iron values for many tributaries are calculated based on synoptic study inflow concentrations (Boughton, 2001)

??% - lacking data to make estimate

SECTION 5.0
RESTORATION STRATEGY

5.1 New World Mining District Response and Restoration Project

The restoration strategies for Daisy Creek, the Stillwater River, Fisher Creek, the Clarks Fork of the Yellowstone River and Miller Creek are primarily addressed by activities associated with the New World Mining District Response and Restoration Project. The USDA-FS is currently proceeding with efforts to implement the *New World Mining District Response and Restoration Project Overall Project Workplan* (Maxim, 1999; also referred to as the *Final Workplan*) with the intent of satisfying the requirements of the *Consent Decree* and the *Petition Report*. According to the workplan, the USDA-FS will execute the response and restoration project by following guidance provided by the EPA for Non-time-critical removal actions. Non-Time-Critical Removal Actions are defined by the Comprehensive Environmental Response, Cleanup, and Liability Act (CERCLA) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) as actions that are implemented by the lead agency to respond to "the cleanup or removal of released hazardous substances from the environment … as may be necessary to prevent, minimize, or mitigate damage to the public health or welfare or to the environment…".

The primary goals of the New World response and restoration project, as identified in the workplan, are:

1. to assure the achievement of the highest and best water quality practicably attainable on District Property, considering the natural geology, hydrology and background conditions in the District and,
2. to mitigate environmental impacts that are a result of historic mining, "… taking into consideration the desirability of preserving the existing undeveloped character of the District and the surrounding area."

The workplan also presents additional project goals and objectives, a few of which are listed below:

- Prevent soluble metal contaminants or metals contaminated solid materials in the waste rock and tailings materials/sediments from migrating into adjacent surface waters to the extent practicable.
- Reduce or eliminate concentrated runoff and discharges that generate sediment and/or heavy metals contamination to adjacent surface waters and groundwater to the extent practicable.
- Identify, prioritize, and select response and restoration actions based on a comprehensive source assessment and streamlined risk analysis of District Property.
- Restore a functional balance to the ecosystem that corresponds to the management objectives of the Gallatin National Forest and Custer National Forest Management Plans.

According to the workplan, the USDA-FS envisions that response and restoration work will initially focus on stabilizing the solid mine wastes to prevent or reduce erosion onto adjacent lands or into streams. Other expected response or restoration actions may include:

- Installing appropriate water management systems and, if necessary, operating a water treatment system during the construction phase of various response actions.
- Preparing repository sites to receive consolidated waste materials.
- Engineering appropriate capping systems to reduce potential infiltration through the waste materials to minimize further oxidation and acid production of mineralized materials.
- Closing adits and shafts.
- Revegetating mining-disturbed areas.
- Monitoring water quality.

The philosophy of the USDA-FS, as stated in the workplan, is to achieve the goals stated above to the extent practicable and possible given the constraints of funding and the general desire to blend the response and restoration actions into the surrounding area.

The *Final Work Plan* goes on to identify specific source areas, most of which are identified within Figures 2-2, 2-3, 3-1, 3-2, 4-1, and 4-2 of this report. The *Final Work Plan* also includes monitoring plans and a community relations plan. As part of the overall implementation strategy, annual workplans are prepared to detail the work that will be done to implement the yearly removal action and to plan for the removal action that will be done in the following year. For the work that will be completed each year, an engineering evaluation/cost analysis (EE/CA) will be developed. The EE/CA will identify and screen applicable removal technologies and process options.

The above approach is consistent with the performance based allocation approach for identified metals and pH problems in Daisy Creek, the Stillwater River, Fisher Creek, the Clarks Fork River, and Miller Creek.

Since completion of the workplan in 1999, restoration efforts, monitoring and characterization, and community relations efforts have been ongoing as envisioned within the workplan. Annual workplans and EE/CAs have been completed for 2000, 2001, and 2002, resulting in restoration activities and studies that have been completed or are underway.

Restoration and related efforts either completed or currently in progress include the following:

- Development of a repository site for the relocation of mine wastes,
- Removal of mine wastes in several locations in the Fisher Creek drainage,
- Removal of the Soda Butte Tailings Dump and the Rommel Tailings in the upper portion of Soda Butte Creek drainage,
- EE/CA for the McLaren Pit area,
- Fisher Cr. Road improvement work to reduce erosion and improve access, and

- Significant additional characterization, including further characterization of the Glengary Adit, to assist with future EE/CA and annual work plan development.

5.2 Additional Restoration Strategy Considerations by Drainage Area

5.2.1 Daisy Creek and the Stillwater River

As previously discussed, the two categories of work as defined by the Natural Resources Working Group for the New World Mining District Response and Restoration Project are:

- Category A - hazardous substances (i.e. mine waste) that are on District Property and non-hazardous substances (e.g. principally sediment from roads) on District Property. Work can be done prior to the receipt of the Notice of Completion from the United States Government.

- Category B – after receipt of the Notice of Completion, work can address other hazardous and non-hazardous sources on non-District Property. Since the Forest Service does not have the authority to do work on private land, then another entity such as the State of Montana or the EPA may need to perform the actual cleanup work for Category B sources on private lands.

Based on source assessment results, it is assumed that all significant sources of metals and pH impairment conditions for both Daisy Creek and the Stillwater River will be addressed under Category A as part of the New World Mine restoration project. Note that Category A includes non-hazardous substances and will therefore address sediment reductions in the Daisy Creek drainage in anticipation of satisfying sediment targets for both streams.

Additional sediment load reductions that fall under Category B may end up being addressed by New World Project activities or by Gallatin National Forest road and trail work. The Gallatin National Forest is now beginning a travel plan Environmental Impact Statement (EIS) process to examine all forest roads and trails in the Gallatin National Forest (including the Cooke City area). The travel plan will address the ultimate disposition; modification, maintenance, closure, removal, etc. for forest roads and trails. Preliminary information pubic meetings and scoping has started and the final EIS is scheduled for completion in the fall of 2004. The EIS will include disclosure of effects of roads on natural resources including water quality and sediment.

5.2.2 Fisher Creek and the Clarks Fork River

Similar to the Daisy Creek drainage, there appears to be a high likelihood that all significant sources of metals and pH impairment conditions in the Fisher Creek drainage will be addressed by Category A restoration efforts. It also appears that any needed sediment reductions will be achieved via New World Mine restoration work (Category A) or via additional Category B and/or Forest Service road and trail maintenance to be defined by the forest roads and trails EIS.

Addressing the Fisher Creek metals and pH impairment concerns will address the vast majority of loading to the Clarks Fork River. Nevertheless, there needs to be an assessment and characterization of potentially significant mining sources in the Lady of the Lake Creek and Broadwater River drainages. This assessment will need to identify any additional load allocations requirements to ensure meeting Clarks Fork River targets in addition to protecting beneficial uses for Lady of the Lake Creek and the Broadwater River. If a significant source is located, then it has the potential of being addressed by New World Mine District activities under Category B, or will otherwise need to be addressed by another restoration approach as discussed below in Section 5.3.

5.2.3 Miller Creek

Because of a much higher proportion of private, non-District property within the Miller Creek drainage in comparison to the Daisy or Fisher Creek drainages (reference Figure 4-1), there is a higher likelihood of significant metals sources that would fall within Category B instead of Category A. If New World Mining Project funding is not adequate to address all significant Category B sources of metals, then individual load allocations will need to be developed and restoration will need to be pursued under a different approach as discussed below in Section 5.3.

The higher metals concentrations seen during higher flows is an indicator of potential metals loading associated with erosion. The inclusion of District property roads under Category A and efforts to address forest roads and trails under the EIS discussed above could result in significant reductions of metals loading via erosion.

5.2.4 Soda Butte Creek

As discussed in Chapter 4, there are several significant source areas contributing to metals impairment conditions in Soda Butte Creek. The restoration strategy for Miller Creek is discussed above in Section 5.2.3. Essentially all other significant sources are potential Category B sources, with the McLaren Tailings representing one of the more significant source areas of concern that could be addressed by New World Mine restoration efforts provided that there is sufficient funding after addressing Category A sources. There will likely be several significant metals sources that will need to be addressed via other approaches as discussed under Section 5.3 below.

At this time, there are currently efforts underway to characterize and identify restoration options for the McLaren Tailings. This work is summarized in the *Draft Final Expanded Engineering Evaluation/Cost Analysis; McLaren Tailings Site, Cooke City, Montana* (Pioneer, 2002). The MDEQ is also working on efforts to reduce environmental impacts associated with the Republic Mine and Mill sites along Republic and Woody Creeks under the Abandoned Mine Lands Reclamation Program. There is still a significant need to further characterize impacts from these and other sources located along Soda Butte Creek or within other drainages such as Wyoming Creek, Republic and Woody Creeks, Sheep Creek, and Unnamed Creek. Some monitoring and assessment recommendations for this work are included below in Section 5.4.

Similar to Miller Creek, some high flow loading could be coming from roads and trail and may end up being addressed, at least in part, by the forest roads and trails EIS discussed above.

5.3 Restoration Approaches for Metals Sources

Each significant source of metals loading, particularly those associated with historical mining, may have one or more restoration options associated with it. These options can include a broad range of regulatory and/or voluntary approaches. The four approaches that are probably most applicable in the Cooke City TMDL Planning area include:

- The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA);
- The Montana Comprehensive Cleanup and Restoration Act (CECRA) which incorporates additional cleanup options under the Controlled Allocation of Liability Act (CALA) and the Voluntary Cleanup and Redevelopment Act (VCRA);
- Abandoned Mine Lands (AML) Reclamation Program;
- Cleanup on federal agency lands outside the context of one of the above regulatory approaches.

The four above approaches as well as some additional options and funding considerations are defined in further detail within Appendix H. As discussed throughout this document, New World Mine restoration efforts are being pursued under CERCLA. Other areas where additional restoration will need to be pursued include the McLaren Tailings, the McLaren Mill Site, and other sources within the Soda Butte Creek drainage area and possibly sources within the Lady of the Lake and Broadwater River drainage areas. In some cases, such as for the Republic Mine and Smelter, the Abandoned Mines Land Reclamation Program is pursuing some or all restoration work needed.

It is assumed that the Forest Service will pursue funding and restoration planning for any significant sources which are located on Forest Service property and cannot be addressed via the New World Mine restoration project. Some of these potentially significant sources can be identified within Figures 3-1 and 4-1.

Any additional restoration work needed on private lands in Montana will probably need to be pursued using one or more approaches identified in Appendix H. If there are restoration needs identified for private lands located in Wyoming, as may be the case where drainage areas originate in Wyoming and then flow into Montana, then the State of Montana will need to work closely with Wyoming and EPA representatives to identify and pursue restoration options needed to support Montana's water quality standards. Since Wyoming water quality standards are primarily based on dissolved metals versus total recoverable metals, some streams that originate in Wyoming may not be identified as being impaired water bodies in Wyoming because elevated metals concentrations may be in a total recoverable form.

All restoration planning will need to be pursued in a comprehensive manner that addresses water quality standards both in the tributary of concern as well as within the downstream water body. For Soda Butte Creek, it will be necessary to further define loading contributions, including any elevated natural background conditions, from all tributaries during low and high flow events. Once contributions are identified, the specific load reduction needs, as partly defined by Tables 4-9 and 4-10, can be further allocated by tributary to ensure protection of Soda Butte Creek's beneficial uses. Once the needed load reductions are identified, then individual metals sources and their relative seasonal contributions can be quantified using existing or yet to be obtained data. A similar approach also needs to be pursued for Lady of the Lake Creek and the Broadwater River drainages, as well as any significant sources that cannot be fully addressed via the New World Mine restoration project. Once this characterization work is completed, it can then provide a means to prioritize restoration efforts, help justify the selection of a given restoration approach, and help with efforts to fund any such approach. Appendix H provides a separate section that discusses some of the funding considerations and options that can apply.

Identification of additional restoration as discussed above will need to be coordinated with ongoing and planned water quality restoration efforts and studies in the area, and also coordinated with state and federal agencies as well as other key stakeholders. Formation of a stakeholder watershed group could help facilitate coordination throughout the Cooke City TMDL Planning Area and could help prioritize studies and restoration efforts not addressed via the New World Mine District Response and Restoration Project. For activities that eventually do not fall under the New World Mine project, the MDEQ will ultimately be responsible for providing direction to other agencies and entities performing water quality work in Montana to ensure characterization efforts and restoration goals are consistent with water quality standards. The MDEQ will also need to ensure internal coordinate between mine reclamation and other MDEQ programs, such as the TMDL and Standards Programs, to evaluate progress toward meeting water quality targets.

5.4 Adaptive Management Approach to Restoration Targets and TMDLs for Metals and pH

The metals and pH targets and associated TMDLs all revolve around values associated with supporting the beneficial uses of a B-1 classified stream (or A-1 for portions of the Stillwater River and Soda Butte Creek). Where there is a need for very high load reductions it is important that every potentially significant source of metals and pH lowering constituents be addressed via all reasonable land, soil, and water conservation practices to achieve the highest and best water quality practicably attainable. Nevertheless, it is recognized that a combination of natural background loading and achievable load reductions may limit the ability to reach one or more of the targets, even after all reasonable land, soil and water conservation practices are defined and applied to pollutant sources. For this reason an adaptive management approach, consistent with the performance-based allocation for most of the water bodies in this WQRP, is undertaken for the metals and pH targets. Under this adaptive management approach, each metal or pH target identified in Tables 2-5, 3-3, or 4-5 will ultimately fall into one of the three categories identified below:

1) The target is achieved or likely will be achieved due to the successful performance of restoration efforts.

2) The target is not achieved and will likely not be achieved even though all applicable restoration efforts have been undertaken in a manner that is considered sufficient application of all reasonable land, soil and water conservation practices. Under this scenario, site-specific water quality standards and/or a reclassification of the water body may be necessary. This would then lead to a new target (and TMDL) for the pollutant of concern, and this new target would either reflect the existing conditions at the time or the anticipated future conditions associated with the restoration work that was performed.
3) The target is not achieved and will not likely be achieved due, at least in part, to a failure to implement all applicable restoration efforts in a manner that is considered sufficient application of all reasonable land, soil and water conservation practices. Under this scenario the water body remains impaired in recognition of the need for further restoration efforts associated with the pollutant of concern. The target may or may not be modified based on additional characterization efforts, but conditions still exist whereby additional pollutant load reductions are needed to support beneficial uses and meet applicable water quality standards via some form of additional restoration work.

Once all targets either fall under categories 1) or 2), then restoration efforts will have been implemented at a sufficient enough level to lead to conditions where applicable beneficial uses are or will be supported in a manner that is consistent with either existing or modified water quality standards. Continuous feedback associated with the performance of restoration work and follow-up monitoring in the area will provide the information to make decisions about the appropriateness of any given target. This feedback will include the MDEQ reports to the Board of Environmental Review as required under the temporary water quality standards process and discussed within Section 1.3.3. The feedback will also involve activities associated with satisfying *Consent Decree* requirements and implementation of the *Final Work Plan*. For all matters relating to District Property, a final decision concerning the adequacy of restoration efforts and a potential final target category will involve MDEQ, the Forest Service, and other stakeholders. The Board of Environmental Review will also be involved with decisions involving targets that relate to satisfying conditions set out by temporary standards. It is anticipated that all target category decisions associated with District Property will be made prior to 2014 when the temporary water quality standards are no longer in effect.

For activities that eventually do not fall under the New World Mine project, the MDEQ will ultimately need to be a lead agency involved with any determinations of final target categories for each pollutant of concern. These determinations will likely include consultation with key stakeholders and also involve public comment. Many of the Soda Butte Creek targets could remain within Category 3 for some time due to a lack of firm restoration commitments and associated funding for source areas such as the McLaren Tailings.

This adaptive management approach for targets, and the overall implementation strategy for the Cooke City area, relies in part on implementation of a comprehensive monitoring program to assist with decision-making efforts. This program is discussed below in Section 5.5.

5.5 Monitoring Strategy

5.5.1 New World Mining District Long-Term Monitoring Plan

The *Final Overall Work Plan for the New World Mining District Response and Restoration Project* (Maxim, 1999) includes *Appendix D: Long-Term Surface Water Quality Monitoring Plan*. This plan commits to monitoring three times per year for metals, field parameters (including pH), flow, and other constituents. The goal is to capture representative low and high flow events. This monitoring effort will be the primary mechanism to track overall progress toward meeting the targets identified in this Water Quality Restoration Plan. Specific monitoring locations, by stream, include:

Daisy Creek:	DC2 and DC5
Stillwater River:	SW-7
Fisher Creek:	SW-3, SW-4, and CFY-2
Clarks Fork River:	SW6
Miller Creek:	SW2
Soda Butte Creek:	SBC-1, SBC-2, SBSW102 (also referred to as RR-SBSW-102), and SBC-4

The plan incorporates a fairly comprehensive list of metals to sample for. These include aluminum, cadmium, copper, iron, lead, manganese, and zinc.

Note that the above sample locations include all of the primary locations used for evaluating the data in the impaired water bodies covered by this plan, with the exception of Miller Creek at SW5 and the Stillwater River at STW2. Fortunately, metals data for Miller Creek is very similar at locations SW2 and SW5, so either may work for the purpose of tracking initial restoration progress. Routine monitoring at STW2 is not critical since monitoring at DC5 and SW7 bracket this location and all pollutant sources of concern are upstream of DC5.

Note that the Soda Butte Creek sampling locations are strategically located to not only help track restoration progress, but also to also help characterize loading conditions, which is needed for this stream. It will be important to try to perform Miller Creek and Soda Butte Creek sampling at the same time to facilitate this characterization effort.

A few additional recommendations for inclusion in the long-term monitoring plan include:
- Samples should be evaluated for both dissolved and total recoverable aluminum, at least for those locations where there is a history of one or the other occurring at high levels. This should include all locations in Miller Creek and Soda Butte Creek.
- Total recoverable silver data, and possibly dissolved silver data, should be collected at Fisher Creek and Clarks Fork River sampling locations.
- The New World Mining District Monitoring Plan extends through the temporary standards period of 2014. Plans need to be put in place to extend the monitoring as needed beyond this date for select parameters starting 2015. This should include monitoring at established stream locations as well as monitoring the success of

individual restoration sites including monitoring for potential leakage from any repository site(s).

5.5.2 Source Characterization

In addition to routine monitoring described above, New World Mining District efforts will also include significant source characterization to further identify and evaluate the relative impacts from specific sources, evaluate restoration options, and also evaluate the success of specific restoration actions. These additional monitoring plans, as well as results and conclusions associated with the data, will tend to be documented in the yearly District workplans and EE/CAs.

Other recommended source characterization activities throughout the Cooke City area include:

- A study to monitor likely source locations during high flows should be undertaken for Miller Creek.
- Soda Butte Creek and the various tributary source areas will require additional characterization, especially during higher flows, to identify contributions from metals sources. Low flow characterization will also be needed at the mouth and further upstream in several of the Soda Butte Creek tributaries to identify loading from specific mining or other source locations including evaluation of potential contributions from floodplain areas along Soda Butte Creek. This floodplain loading could include impacts from a past tailing dam failure as well as casual dumping of old equipment and other junk along the stream bottom.
- Additional data should be collected and a more comprehensive potential source inventory performed for Lady of the Lake Creek and the Broadwater River to help identify natural background conditions, especially during high flows. This would also help determine the need for TMDL development for these water bodies.
- Information is needed to identify probable natural background loads for most water bodies, especially during high flow events, using reference streams where they can be identified.
- Historical photos, maps, and other land use information should be analyzed to help identify potential mining sources, especially in those drainages outside the current focus of the New World Mining project.
- As metals loading sources are removed, sediment and floodplain metals concentrations should be evaluated to determine whether or not there should be removal efforts. Any such plans should take into consideration the extent of yearly flushing associated with stream sediments and the potential for significant damage to the physical structure of the stream from removal efforts.

Any studies undertaken to address these characterization needs must incorporate proper analyses and sample detection limits for all of the appropriate total recoverable and dissolved metals to effectively evaluate conditions relative to Montana and/or Wyoming Water Quality Standards and WQRP targets.

5.5.3 MDEQ Monitoring Efforts to Develop Targets and Analyze Progress

MDEQ staff will continue to review the data from the New World Monitoring program and utilize the information to make updated status determinations on progress as required at least once every five years per State Law (Montana Water Quality Act, Section 75-5-703). One of the activities associated with the long-term surface water monitoring program is evaluation of diurnal affects on water quality. As an added margin of safety, any statistically significant diurnal affects at concentrations near the water quality targets will be factored into monitoring efforts to evaluate overall compliance with targets. For example, if sampling is performed at a time of day when water quality values are 20% less than average conditions for a given metal, then a 20% reduction factor will be used to determine the probable average concentration for comparison against water quality targets.

Some additional monitoring that will be needed to evaluate progress toward setting and meeting targets include the below items. MDEQ will be responsible for ensuring that these monitoring efforts are undertaken and that the data is made available to appropriate stakeholders. Some of the actual monitoring may be done by New World Mine project personnel or other stakeholders working in the drainage.

- At least once every five years, sediment chemistry samples should be taken to determine copper and lead levels at sites SW7, DC5, SW4, SW6, SW2, and SBC2. The purpose is to measure progress toward meeting the targets of sediment concentrations at non-toxic levels and to ensure that there are not toxicity concerns at those locations where sediment data has not been identified as a problem for these two metals.
- Monitoring to evaluate progress toward meeting percent fines goals for Daisy Creek and the Stillwater River will be performed at least once every five years. The locations used for developing the Wolman Pebble count curves, or suitable replacements, are recommended. These sites are identified on Figure 1-5 as SED-1, SED-2, and SED-3. The measurements should be made at the same time during the lower flow summer or fall season after spring runoff conditions. During these measurements, turbidity and streambed deposits associated with metal precipitants will need to be characterized, using pictures and/or field observation notes at a minimum for the SED-2 and SED-3 sites as well as DC5.
- For Fisher Creek, the MDEQ will need to identify one or more reference streams and obtain percent fines data as was done for Daisy Creek and the Stillwater River. It is recommended that location SED-4 or a similar area where some of the best fish habitat exists be used for the percent fines measurements. The information can then be used to evaluate progress toward meeting the sediment target. The development of these reference stream target curves can be done at the same time of, or prior to, the five year monitoring.
- Macroinvertebrate and periphyton samples will need to be collected in each stream at least once every five years or as restoration work reaches a point where collection of such information will be useful to evaluate this particular restoration target.

MDEQ protocols will be followed for all sediment and biological sampling as well as for any water chemistry samples taken.

SECTION 6.0
PUBLIC INVOLVEMENT

Public review and involvement for development of this water quality restoration plan has been ongoing to some extent since the 303(d) lists that MDEQ develops every two years undergo public review, including public meetings. As for this Draft Water Quality Restoration Plan, a one-month public comment period was started in January, 2002, and included public meetings held in Cooke City and Livingston during the public comment period. MDEQ has reviewed and responded to the comments and attempted to incorporate them where possible. Appendix I is a list of the comments with MDEQ responses.

Because a large part of this overall plan revolves around restoration planning efforts for the New World Mining District, the public has had and continues to have the opportunity to review and comment on many of the aspects of this plan, particularly those associated with site characterization and specific restoration strategy development. In addition, the public will continue to have the ability to participate in the implementation of the performance-based approach and overall restoration efforts through comment on yearly workplans and EE/CAs. This additional level of public involvement is facilitated through Forest Service personnel in charge of New World Mining District Restoration efforts and described within the Community Relations Plan portion of the *Final Overall Project Work Plan* (Maxim, 1999).

Restoration work pursued outside the context of the New World Mining project will typically involve numerous stakeholders, including the affected public. A high level of public interest in restoration work, as is evident by the comments in Appendix I, makes it very likely that there will be continued, if not increased, public involvement with overall restoration efforts in the area. This can include comment on eventual target categories as described in Section 5.4. Public comment on target categories could be facilitated via comment on New World Mining district restoration plans, agency decisions associated with temporary standards or water body classifications, and/or comment on restoration plans outside the context of New World Mining project efforts.

Any future significant revisions to this plan or identification of water quality impairment conditions on future 303(d) lists will also undergo public review.

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